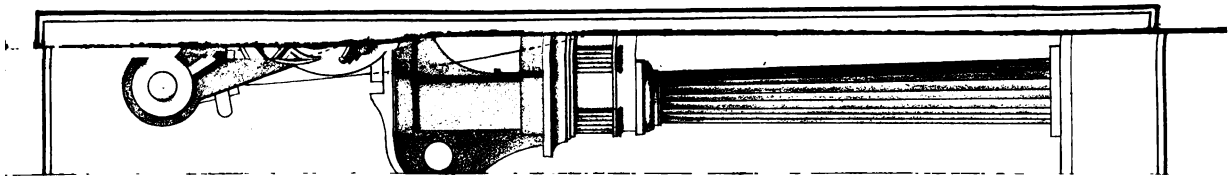
THE ENGINEER'S
COMMON-PLACE BOOK
OF
PRACTICAL REFERENCE.

THIRD EDITION, IMPROVED.

BY WILLIAM TEMPLETON.

With Four Lithographic Illustrations.

PRICE FIVE SHILLINGS.



THE ENGINEER'S

COMMON-PLACE BOOK

OF

PRACTICAL REFERENCE,

CONSISTING OF

PRACTICAL RULES AND TABLES

FAMILIARLY ADAPTED TO

FACTORY AND MARINE STEAM-ENGINES.

TO WHICH IS ADDED,

EXTENSIVE TABLES OF CIRCUMFERENCES, SQUARES, CUBES, AND AREAS OF CIRCLES; SQUARE AND CUBE ROOTS OF NUMBERS, WITH THEIR DIFFERENCES, FOR FACILITATING

FRACTIONAL CALCULATIONS;

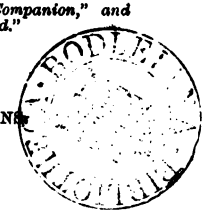
SUPERFICIES AND SOLIDITIES OF SPHERES, &c., &c., WITH OTHER USEFUL TABLES, EQUALLY ADAPTED TO PRACTICAL PURPOSES.

BY WILLIAM TEMPLETON.

Author of "The Millwright and Engineer's Pocket Companion," and "Locomotive Engine Popularly Explained."

THIRD EDITION, IMPROVED.

WITH LITHOGRAPHIC ILLUSTRATIONS.



LONDON:

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SMITH, ROGERSON, AND CO., PRINTERS, LIVERPOOL.

PREFACE.

When a new edition of any work is presented to the public, it is generally expected to bring along with it some new claim to public estimation, without which its merits could not be recognised, and, consequently, because of retaining the old title, it would, in all probability, be deemed nothing more than a mere reprint of the original work.

In compliance with this feeling, the author of the Common-place Book begs to submit this edition to the notice of the public, the work having not only been diligently revised, but almost entirely re-written, and matter of much importance added, with a view of creating a more general interest in the minds of junior engineers, and other individuals, whether immediately connected with the profession, or about to study the popular principles and advantageous management of the steam-engine.

When the work was first undertaken, it was written in some measure to induce to algebraic investigations from practical results; rules thus deduced being considered not only more elucidative, but also more general in application, and more easily borne in mind; however, in testing this by public opinion, I have been taught the reverse, for which reason I have withdrawn all formula and substituted instead, rules in the most simple arithmetical form.

The locomotive department has also been with-

drawn, because although the locomotive be an engine, or machine on the non-condensing principle, its construction and mode of working are so complex, that nothing less than a volume entirely devoted to its own peculiarities could possibly do that justice which the merits of the machine demand; and this having already been completed, it is hoped that in the two combined, much useful information for reference will be found on common-place subjects relative to steam and the steam-engine by those to whom it is addressed.

But still farther to enhance the value of the work, a number of very elaborate tables have been added, in order to evade, as much as possible, any loss of time or tendency to inaccuracy in making calculations, in which, unavoidably, the circle and the square require taking into account in a comparative form; such as superficial contents of a circle in square inches or in square feet, the cubic contents of cylinders and of spheres, the ratios of circles and squares, the ratios of spheres and cubes, &c., &c., with other tables of equal importance; hence, it is presumed, that, taking the work as a whole, it will be found not only an important compendium of practical matter relative to the steam-engine, but also an advantageous store of useful reference for the abbreviation of mathematical investigations for practical purposes by men of business in general.

March, 1848.

CONTENTS.

MATHEMATICAL TABLES.

THE PRACTICAL

ENGINEER'S COMMON-PLACE BOOK, &c.

ALGEBRAIC SIGNS,

AS APPLIED IN MECHANICAL CALCULATIONS.

=	Sign of Equality, and signifies	equal to .....as 3 added to 4 = 7.
+	Addition	.....plus, or more.....5 + 3 = 3.
−	Subtraction	.....minus, or less .....8 − 3 = 5.
×	Multiplication	.....multiplied by .....8 × 3 = 24.
÷	Division	.....divided by..24 ÷ 4 = 6, or $\frac{24}{4}$ = 6.
: :: :	Proportion	.....that 2 is to 3 as 4 is to 6.
$\surd$	Square Root	.....Evolution, or the extraction of roots,
$\sqrt[3]{}$	Cube root	thus, $\surd 64 = 8$, and $\sqrt[3]{64} = 4$.
4^2	to be squared	.....Involution, or the raising of powers,
4^3	to be cubed	thus, $4^2 = 16$, and $4^3 = 64$.

$\overline{3 + 5} \times 4 = 32$ .....that 3 plus 5 multiplied by 4 = 32.

$\surd \overline{5^2 - 3^2} = 4$...5 squared, minus 3 squared, the square root of the remainder = 4.

$\frac{\sqrt[3]{\overline{20 \times 12}}}{30} = 2$...20 multiplied by 12, and divided by 30, the cube root of the quotient = 2.

$\frac{\overline{24 \times 6} + \overline{12 \times 3 \times 4}}{12} = 60$...24 multiplied by 6, and 12 multiplied by 3, added together, multiplied by 4 and divided by 12, the quotient = 60.

$\frac{A\ V\ Q}{n\ l} = d$...that A, V, and Q, multiplied together, and divided by n multiplied by l, the quotient = d.

$\frac{\overline{P - p} \times d}{W} = D$... P minus p multiplied by d, and divided by W = D

$S = \frac{V\ \overline{[(q\ M + F)\ D + p\ d^2\ l]}}{m\ P\ D}$...$q$ multiplied by M, plus F, and multiplied by D, plus p, multiplied by d squared, and by l, the whole sum multiplied by V, and divided by the product of m P D, the quotient = S.

IMPERIAL STANDARD MEASURES.

1. MEASURE OF LENGTH.

Inches.									
12	.....	1 foot.							
36	.....	3	.....	1 yard.					
198	.....	16½	.....	5½	.....	1 pole or perch.			
7920	.....	660	.....	220	.....	40	.....	1 furlong.	
63360	.....	5280	.....	1760	.....	320	.....	8	1 mile.

The French metre or Standard measure of length = 39.371 in.

SPECIAL MEASURES OF LENGTH.

Nautical Measure.	*Land Measure.*
1 nautical mile = 6082.66 ft.	7.92 inches = 1 link.
3 miles = 1 league.	100 links = 1 chain.
20 leagues = 1 degree.	80 chains = 1 mile.
360 degrees = earth's cir.	69.121 miles = 1 geo. deg.

6 feet = 1 fathom, used in measuring ropes, chains, &c.

A Table of the common fractional parts of an inch and a foot, with their corresponding decimals.

Fractions of an inch.	*Decimals.*	*Fractions of an inch.*	*Decimals.*	*Fractions of a foot or inches.*	*Decimals.*
7/8 & 3/32	= .96875	3/8 & 5/32	= .46875	11	= .9166
7/8 & 1/16	= .9375	3/8 & 1/16	= .4375	10	= .8333
7/8 & 1/32	= .90625	3/8 & 1/32	= .40625	9	= .75
	= .875	3/8	= .375	8	= .6666
3/4 & 5/32	= .84375	1/2 & 5/32	= .34375	7	= .5833
3/4 & 1/16	= .8125	1/2 & 1/16	= .3125	6	= .5
3/4 & 1/32	= .78125	1/2 & 1/32	= .28125	5	= .4166
3/4	= .75	1/2	= .25	4	= .3333
5/8 & 3/32	= .71875	1/8 & 5/32	= .21875	3	= .25
5/8 & 1/16	= .6875	1/8 & 1/16	= .1875	2	= .1666
5/8 & 1/32	= .65625	1/8 & 1/32	= .15625	1	= .0833
5/8	= .625	1/8	= .125	7/8	= .07291
1/2 & 5/32	= .59375	— & 5/32	= .09375	3/4	= .0625
1/2 & 1/16	= .5625	— & 1/16	= .0625	1/2	= .0528
1/2 & 1/32	= .53125	— & 1/32	= .03125	1/2	= .04166
1/2	= .5			3/8	= .03125
				1/4	= .02083
				1/8	= .01041

2. MEASURE OF SURFACE.

Inches.						
144	1 square foot.					
1296	9	1 square yard.				
39204	272¼.....	30¼.....	1 square pole.			
1568160	10890	1210	40	1 rood.		
6272640	43560	4840	160	4	1	acre.

SPECIAL MEASURES OF SURFACE.

Land Measure.

62.7264 square inches = 1 square link,
10000 „ = 1 „ chain, and
10 square chains = 1 acre.

3. MEASURES OF CAPACITY.

General Measure of Solidity.

1728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
42 cubic feet = 1 ton of shipping.

4. IMPERIAL GALLON MEASURE FOR LIQUIDS, CORN, &c.

Cubic inches.	Water lbs. av								
8.665	$\frac{5}{16}$	1 gill.							
34.659	1¼	4 ...	1 pint.						
69.318	2½	8 ...	2 ...	1 qrt.					
277.274	10	32 ...	8 ...	4 ...	1 gal.				
554.548	20	64 ...	16 ...	8 ...	2 ...	1 peck.			
2218.19	80	256 ..	64 ...	32 ...	8 ...	4 ...	1	bushl.	
17745.5	640	2048 ...	512 ...	256...	64 ...	32 ...	8 ...	qr.	

The peck, bushel, and quarter, are used for dry goods only.

1 gallon of sea water = 10.32 lbs. avoir.
1 „ oil = 9.32 „
1 „ proof spirits = 9.3 „
1 bushel of wheat = 60 „
1 „ barley = 47 „
1 „ oats = 38 „

The old ale gallon contained 282 cubic inches; and
The old wine gallon 231.

The French litre, or standard measure of capacity for liquids, contains 61.028 cubic inches, or about .453 of our imperial gallon.

5. IMPERIAL MEASURE OF CAPACITY FOR COALS, CULM, LIME, FRUIT, &c.

351.9375 cubic inches	1 gallon.					
703.875	2 ...	1 peck.				
2815.5	8 ...	4 ...	1 bushel.			
4.688 cubic feet	24 ...	12 ...	3...	1 sack.		
58.656	288 ...	144 ...	36 ..	12...	1 chaldron.	

In and about London coals are sold by the cwt., ton, &c., but in Yorkshire, and many other places, they are sold by the bag, and estimated as follows:—

1 bag = 2 bushels, and weighs about 140lbs.
16 bags = 1 ton, and 24 bags = 1 chaldron, or 30 cwt.

A keel of coals at Newcastle is 21 tons 4 cwt., and a chaldron of 53 cwt. A chaldron of coals in London is 28½ cwt.

6. AVOIRDUPOIS WEIGHT.

Troy Grains.							
27.34375	1 dram.						
437.5	16...	1 ounce.					
7000	256...	16...	1 lb.				
98000	3584 ..	224...	14...	1 stone.			
196000	7168...	448...	28..	2...	1 quarter.		
784000	28672...	1792...	112...	8...	4...	1 cwt.	
15680000	573440...	35840...	2240...	160..	80...	20...	1 ton.

The French gramme, or standard measure of weight, equal 15.434 troy grains, and the kilogramme 2.20486 lbs. avoir.

About	426 cubic inches	of cast iron	= 1 cwt.
	8520 „	or	
nearly	5 cubic feet		= 1 ton.
	13 „	of stone	= 1 ton.
	23 „	sand	= 1 ton.
	29 „	coal	= 1 ton.
	38 „	tallow	= 1 ton.
	39 „	oil	= 1 ton.
	40 „	timber	= 1 ton.
	36 „	com. water	= 1 ton.
	35 „	sea water	= 1 ton.

Table of Specific Gravities.

NAMES OF BODIES.	Weight of a cubic foot in lbs.	Weight of a cubic in. in ounces.	Number of cubic inches in a lb.	Weight of a cubic inch in lbs.
Copper, cast	549.25	5.086	3.146	.3178
Copper, sheet	557.18	5.159	3.103	.3225
Brass, cast	524.75	4.852	3.223	.3037
Iron, cast	454.43	4.203	3.802	.263
Iron, bar	476.93	4.410	3.623	.276
Lead	709.00	6.456	2.437	.4103
Steel, soft	489.56	4.527	3.530	.2833
Steel, hard	488.50	4.517	3.537	.2827
Zinc, cast	449.37	4.156	3.845	.26
Tin, cast	455.75	4.215	3.790	.2636
Bismuth	619.50	5.710	2.789	.3585
Gun metal	549.00	5.077	3.147	.3177
Sand	95.00	.878	18.190	.055
Coal	78.12	.722	22.120	.0452
Brick	125.00	1.156	13.824	.0723
Stone, paving	151.00	1.396	11.443	.0873
Marble	171.37	1.585	10.083	.0991
Glass	180.00	1.664	9.600	.1042
Tallow	59.06	.546	29.258	.0342
Cork	15.00	.138	115.200	.0087
Oak	60.62	.561	28.505	.0351
Pine, pitch	41.25	.382	41.890	.024
Ash	47.50	.440	36.370	.0275
Spirits, proof	57.93	.536	29.828	.0335
Mercury	848.00	7.851	2.037	.4908

A Table of the specific gravity of water at different temperatures, that at 62 being taken as unity.

70°F.	.99913	52°F.	1.00076
68	.99936	50	1.00087
66	.99958	48	1.00095
64	.99980	46	1.00102
62	1.	44	1.00107
58	1.00035	42	1.00111
56	1.00050	40	1.00113
54	1.00064	38	1.00115

Note. The difference of temperatures between 62° and 42°, where water attains its greatest density, will vary the bulk of a gallon rather less than the third of a cubic inch.

WATER.

Water, in an aëriform state, constitutes the steam-engine a moving power; consequently to the practical engineer some knowledge of the chemical and mechanical properties of water must be not only interesting, but of considerable importance in other points of view.

Water, or oxide of hydrogen, is a fluid composed of two elementary bodies, or gases, viz., oxygen and hydrogen, the union of which are so compact that its compressibility with the utmost application of force is so small, that in practice it is with propriety termed generally an incompressible fluid.

Proportions of the gases are the following:—

	WEIGHT.	BULK.
Oxygen	8	1
Hydrogen	1	2
Equivalents	9	3

Or one cubic inch consists of

	GRAINS.	CUBIC INCHES.
Oxygen	224.46	662
Hydrogen	28.06	1325
	252.52	1987

Water, when pure, is transparent, colourless, tasteless, nodorous, and not liable to spontaneous change; liquid at the common temperature of our atmosphere; assuming a solid form at 32° Faht., and a gaseous state at 212°, but returning unaltered to its liquid state on resuming any degree of heat between these points; dissolves numerous vegetable, animal, and mineral substances; is decomposed in many cases of chemical action, affording oxygen or hydrogen to the substances which affect it.

Clean iron and zinc at a red heat possess the property of decomposing water when in the state of highly rarefied steam; the oxygen uniting with the metal, a solid metallic crust is formed on the surface, and the hydrogen set at liberty; one volume of oxygen, or from five to

six of atmospheric air, mixed with two of hydrogen, render the mixture inflammable, and on the approach of a flame, red-hot iron, or the electric spark, the whole is kindled at the same instant, a flash of light passes through the mixture, followed by a violent explosion, the result of which is steam at 212° Faht., and ultimately pure water.

But water, as it exists in nature, contains various saline or earthy matters; as muriate of soda, or common salt, sulphate of lime, carbonate of lime, muriate of magnesia, oxide of iron, &c., accumulated in flowing through the different strata of rocks and minerals, constituting mineral or hard water, by which it is considerably reduced in value for the purposes of a steam-engine. Rain and snow waters are the purest natural waters we possess, and are generally employed as the standard of comparison for the densities of other bodies.

Specific gravity of pure rain water = 1, or one cubic foot at a mean temperature of the atmosphere = 1000 ounces.

Ten pounds of rain or distilled water, at 62° Faht., equal the standard gallon, or measure of capacity.

And one cubic inch, at 62° Faht. = 252.458 grains.

Mineral waters of every description are more or less injurious to a boiler; and, unless very frequently changed, become in a state of saturated solution, in consequence of which earthy matters are deposited, and an incrustation formed on the surface of the iron, preventing the free passage of caloric; hence, the plates get red hot, and render the boiler in danger of being destroyed.

Mineral waters are generally divided into four classes, namely, the *acidulous*, the *sulphureous*, *chalybeate*, and *saline*.

Acidulous waters contain carbonic acid in its free state, or in combination in excess with a base; also, very frequently muriate of soda, and some of the earthy carbonates; however, it is the free carbonic acid that

imparts to them their particular properties. These waters are easily distinguished by their slightly acid taste, and sparkling appearance when poured from one vessel to another, both of which properties they lose by boiling, or standing exposed to the air for any short length of time.

Sulphureous waters contain sulphureted hydrogen, also alkaline, earthy sulphates, and muriates; they are very readily distinguished by their odour, and by causing a piece of silver, when immersed in them, to acquire a dark colour.

Chalybeate waters are those which have iron as an ingredient; they are known by their peculiar taste, and by their becoming black when mixed with an infusion of nutgalls; but they are of different kinds; sometimes the iron is combined with sulphuric acid,—more frequently it is in union with carbonic acid.

Saline waters are those which contain the saline ingredients generally found in mineral waters, but which have not carbonic acid in excess, and are free from sulphureted hydrogen and iron, or contain them in very trifling quantities. Saline waters may be subdivided into four kinds, namely—alkaline waters, or those which contain alkali in its free state, or combined with carbonic acid, and which render the vegetable blues green; hard waters, or those which combine carbonate or sulphate of lime; salt waters, or those in which muriate of soda abounds; purgative waters, or those which contain principally sulphate of magnesia.

To ascertain the properties of any water, the following experiments may be resorted to:—

1. Evaporate a drop on a flat slip of glass, holding it before the fire, or above a small lamp or candle. Small rings only appear where the water rested, if it contained only a minute quantity of foreign matter; but a crust is seen if it be loaded with saline or earthy matter, and the crust has an ochry tint if *iron* be present.

2. Pour some of the water into a wine glass, and add a solution of litmus; it will be reddened if any free acid matter be present.

3. Mix another portion with a little soap; a curdy matter appears if it abound with earthy matter.

Sea water contains of saline and *earthy* matter in every 100 parts,

Common salt	2.66
Sulphate of soda	.466
Muriate of lime	.199
Muriate of magnesia	.991
	4.316

parts of saline and earthy matter. Average specific gravity 1028. Hence the necessity of frequently renewing the water in marine engine boilers at sea, by the usual process of *blowing out;* that is, by a little extra feed the boilers are allowed to fill, say, from four to six inches above the regular height, and the overcharged water blown out by the force of the steam, through a cock in the bottom of the boiler, at least once every two hours.

MECHANICAL PROPERTIES OF WATER.

1. Fluid bodies in general exert an equal force or pressure in every direction, namely, upwards, downwards, sideways, and oblique, and fluids always tend to a level; hence, any quantity of water, however small, may be made to balance and support any quantity, however large.

2. The weight of water, or any other fluid body, is as the quantity; but the pressure is as the perpendicular height.

3. The pressure on the sides of any vessel containing a fluid is equal to the length of the side multiplied by half the square of the depth.

4. The centre of pressure, and also the centre of percussion, in a fluid, is two-thirds of the depth from the surface.

5. The quantity of water discharged through an orifice in equal times, but under different heads, is nearly as the corresponding heights of the different heads of water; hence,

$$\frac{\text{The square root of the depth in feet} \times \text{by the falling surface in inches}}{\text{Area of the orifice} \times 3.7} =$$

the time required in seconds.

Maximum density of water 42° Faht.
Freezing point 32° Faht., at which point it has expanded $\frac{1}{17}$ of its original bulk.

62.5 lbs. avoirdupois = the weight of 1 cubic foot.
.03617 ..... = ... 1 " inch.
.434 ..... = ... 1 lineal ft. 1 in. sq.
49.1 ..... = ... 1 cylindrical foot.
.02842 ..... = ...1 " inch.
.341 ..... = ... 1 lin. ft. 1 in. dia.
11.2 imperial galls.. = ... 1 cwt.
224. ..... = ... 1 ton.
1.8 cubic feet..... = ... 1 cwt.
35.84..... = ... 1 ton.
1 cubic foot of water = $6\frac{1}{4}$ imperial gallons, and
1 cylindrical foot = about 5.

The content of any vessel in cubic feet × by 6.232
Or " " inches × by .003607 } = imperial gallons.

$$\frac{\text{Any number of imperial gallons}}{\text{Any two dimensions of a cistern in feet} \times \text{by } 6.232} = \text{the third dimension in feet.}$$

$$\frac{\text{Any number of imperial gallons}}{\text{Any two dimensions of a cistern in inches} \times \text{by } .003607} = \text{the third dimension in inches.}$$

The length of a cylinder in feet × by the square of the diameter in feet, and by 4.895..
The length of a cylinder in feet × by the square of the diameter in inches and by 0.34
The length of a cylinder in inches × by the sqr. of the diameter in inches and by .002832
} = Imp. gallons.

$$\sqrt{\frac{\text{any number of gallons a cylinder is required to contain} \times \text{by } 354}{\text{by the length in inches}}} =$$

the diameter of the cylinder in inches.

$$\frac{\text{Any number of gallons a cylinder is required to contain} \times \text{by } 354}{\text{by the square of the diameter in inches}} =$$

the length of the cylinder in inches.

The cube of the diameter of a sphere in inches × by .001888 = imperial gallons.

The velocity of water in feet per minute × by the square of a pump's diameter in inches, and by .034 = imperial gallons discharged per minute.

The velocity of water in feet per minute × by the square of a pump's diameter in inches, and by .0005454 = cubic feet discharged per minute.

OF STEAM, OR RAREFIED WATER.

When water in a boiler is subjected to the action of fire, it imbibes the heat or caloric that the fire imparts, and sooner or later acquires a degree of temperature at which ebulition takes place, and particles of steam arise through the surface of the water, hence designated the *boiling point;* but the degree of temperature at which this takes place is entirely governed by the density of the fluid pressing on the surface of the water, thus, in a vacuum water boils at about 98° Faht.; under com-

mon atmospheric pressure, at 212°; and to produce steam at 2½ lbs. per square inch, requires a temperature of 220°, &c., as in the following table :—

Temperature in degrees of Fahr.	Force in lbs. per			Temperature in degrees of Fahr.	Force in lbs. per		
	Square inch.	Inches of Mercury.	Feet of Water.		Square Inch.	Inches of Mercury.	Feet of Water.
220	2.5	5.15	5.76	240	10	20 60	23 05
222	3	6.18	6.91	245.5	12	24 72	27.64
223.5	3.5	7.21	8.07	251	15	30.90	34.57
225	4	8 24	9 22	260	20	41.20	46 10
227	4.5	9 27	10.37	268	25	51.50	57 62
228	5	10.30	11.52	275	30	61.80	69.15
230	5.5	11.33	12 68	282	35	72.12	86.67
231.5	6	12.36	13.82	288	40	82 41	92.20
233	6.5	13.39	14.98	294	45	92.70	103.72
234	7	14 42	16.14	299	50	103.00	115.25
235	7.5	15.45	17 28	304	55	113.31	126.77
236	8	16.48	18.44	309	60	123 60	138.30

Steam contains about five times the quantity of heat to that of boiling water; it is transparent and colourless until it comes in contact with the atmosphere, it then assumes a dense white mass, the caloric which maintained its gaseous form is therein absorbed, and hence, in consequence, its properties as steam are eventually destroyed.

The principal properties of steam, relative to the steam-engine, are the following:—

1. Elasticity, or the power that it has to return to its original form, after being made to deviate by some external force.

2. Expansibility, or the increase of bulk which it undergoes by the recession of its particles from one another, so that it occupies a greater space, while its weight remain the same.

3. Condensation, or the causing of the mass to occupy less space, by means of the closer approach of its particles through the abstraction of heat.

Table exhibiting various properties of steam.

Elastic force in atmospheres.	Elastic force in lbs. per sqr. inch.	Degrees of heat.	Difference of temperature.	Volume in cubic feet, water being 1.	Velocity into a vacuum in feet per sec.
1	14.7	212°F		1711	1566
2	29.4	250.52	38.50°F	905	1610
3	44.1	275.18	24.66	623	1638
4	58.8	293.72	18.54	479	1658
5	73.5	308.84	15.12	394	1674
6	88.2	320.36	11.52	331	1688
7	102.9	331.70	11.34	288	1700
8	117.6	341.96	10.26	255	1710
9	132.3	350.78	8.82	229	1720
10	147.0	358.88	8.10	209	1729
12	176 4	374.00	15.12	190	1742
15	180.5	392.86	18.86	135	1765
20	294.0	418.45	25.59	111	1786
30	441.0	457.16	38.71	77	1823
50	735.0	510.60	53.44	42	1873

Hence, from this table it will be inferred, that as such small accessions of heat produce so rapid an increase of elastic force, small abstractions of heat from highly rarified steam, will also reduce its elasticity in an equal degree, so that high pressed steam is more readily diminished in bulk by the application of cold, than steam of less density; that is, it can be more readily reduced in its pressure to any certain proportion of the pressure it had before; thus rendering to the purposes of the steam-engine properties of very economical interest, because by admitting only a small quantity to enter the cylinder through being sooner stopped off, and from thence, by its expansive force, continue the motion of the piston to the end of the stroke, the advantage of which is according to the results as estimated by the following rule:—

Divide the length of the stroke of the piston in a steam engine, by the distance the dense steam has been admitted into the cylinder, previous to its being cut off, and find the hyperbolic logarithm of the quotient, to which add 1, and the sum is the ratio of the gain.

EXAMPLE.—Suppose an engine, with a stroke of 6 feet, and the steam cut off when the piston has moved through 2, required the ratio of gain by uniform and elastic force,

$6 \div 2 = 3$; hyperbolic logarithm of $3 = 1.0986 + 1 = 2.0986$ ratio of effect; that is, supposing the whole effect of the steam to be 3, the effect of the steam being cut off at one-third of the stroke, $= 2.0986$.

But steam produced from water-holding salts, or other impurities in solution, is not of equal density to that produced from pure water, although both be of equal temperatures: thus, from experiment and practice, the steam produced from common water, at 212° Faht., will support a column of mercury 30 inches in height; whereas steam from sea water, at an equal temperature, will support no more of an equal column than $22\frac{3}{4}$ inches. In like manner, the steam from common water, at 220° Faht., will support a column of mercury 35 inches in height; and that from sea water, at an equal temperature, only $26\frac{1}{2}$ inches: hence the great propriety of obtaining water so pure as possible for the generation of steam.

OF THE STEAM-ENGINE, THE BOILER, &c.

The Steam-engine is a machine calculated expressly for the purpose of rendering steam available, as a motive power, to the purposes of machinery; its forms are numerous, but its principles, as a moving cause, depend entirely on that of water in a state of rarifaction by heat.

Water, in its natural state, is an incompressible fluid, but combined with caloric, or the matter of heat, it is changed, and becomes an elastic transparent vapour of great force.

The Boiler or vessel containing the water to which the heat is applied, and in which the steam is generated, is commonly of wrought or plate iron, sometimes of copper, but in form no pecularity is required otherwise than what compulsion dictates, viz., capacity, best form for strength, and a sufficiency of heating surface, to distribute properly the caloric through the water.

There is perhaps nothing which tends more to the inefficiency of a boiler than the want of sufficient capacity—inequality of pressure, frequent priming, and unnecessary waste of fuel, are amongst the common evils resulting therefrom; but unfortunately, practice, in various instances, forbids that amount of capacity which is laid down as a general rule, (*viz., one cubic yard to each horse-power, two-thirds of which to be occupied by water,*) as may not unfrequently be seen in those of marine boilers, locomotives, &c., the defective results of which, in many instances, not being easily construed.

With respect to a sufficiency of heating surface proportionate to the boiler's capacity, or more properly to the quantity of water that must be boiled off in a given time, much descrepancy of opinion still continue to induce dispute; but no doubt a great portion of this may exist, because of parties not being sufficiently explicit in distinguishing between the amount of horizontal and that of vertical or side surface, the efficiency of the former being called, 1, that of the latter is little more than one-half; hence the propriety of giving inclination inwards to the plates of all flues, not only to approximate that of horizontal surface, but also to effect a more ready access to the surface of the water, the caloric or particles of steam generated underneath.

When the horizontal heating surface of a boiler only,

is taken into account, *nine* square feet to each horse-power is considered a sufficiently productive surface; but when the whole heating surface of whatever description is included, not less than *fourteen* square feet to each horse-power can confidently be relied upon, unless the expansive principles in the cylinder of the engine be carried out to a considerable extent.

The dimensions expressed as above, are for engines of customary nominal power, and with about *one* square foot of fire bar to each *fourteen* square feet of heating surface; but the following rules are more intimately adapted, because, to suit the various peculiarities of engines, and the various densities of steam required.

But, in the construction of boilers generally, much attention ought to be paid to the avoiding of thin films of water where the action of the fire is great, because it is neither consistent with safety, nor can there be the proper quantities of steam generated proportionately to the surface exposed, unless under an extraordinary degree of pressure. Also, convex surfaces, exposed to the action of the steam, unless properly supported, ought strenuously to be avoided. Large water spaces, concave surfaces, or straight plates with the butt edges upwards and securely stayed, with ample steam room, are the chief requisites to be attended to.

1. ***To determine the proper quantity of heating surface a boiler ought to contain, for an engine with a cylinder of a given capacity, and steam of any density, as in the following table.***

RULE.—Multiply the area of the piston in square feet, by its velocity in lineal feet per minute, and by the decimal equivalent in the last column of the following table, opposite the required density of steam in the first column, and the product is the heating surface of the boiler in square feet.

EXAMPLE.—Required the amount of effective heating

surface for the boiler of an engine, the area of whose piston is 9 square feet, its velocity 192 feet per minute, and the density of the steam 5lbs. per square inch above the pressure of the atmosphere.

$192 \times 9 \times .3328 = 575$ square feet of heating surface.

NOTE.—By effective heating surface is meant horizontal surfaces over fire, flame, or heated air; vertical or side surfaces requiring about $1\frac{1}{2}$ feet to equal 1 of horizontal surface.

2. *To determine the proper dimensions for a waggon-shaped boiler, the amount of effective heating surface being given.*

RULE.—The bottom surface equal half the whole surface.

The length equal twice the square root of bottom surface.

The width equal one-fourth the length; and

The height equal one-third the length.

EXAMPLE.—Required the dimensions for a boiler of the waggon form, that shall present an effective heating surface of 175 square feet.

Bottom surface $= 175 \div 2 = 87.5$ square feet.
Length $= \sqrt{87.5 \times 2} = 18.72$ feet.
Width $= 18.72 \div 4 = 4.68$ feet.
Height $= 18.72 \div 3 = 6.24$ feet.

3. *To determine the dimensions for a cylindrical boiler.*

RULE.—Extract the square root of 1.34 times the effective heating surface in square feet, and twice the root equal the boiler's circumference in feet; also the circumference equal the length.

EXAMPLE.—Required the diameter and length of a cylindrical boiler, with an effective heating surface of 86 square feet.

$\sqrt{86 \times 1.34} = 10.74 \times 2 = 21.48$ feet circumference, or 6 feet 10 inches diameter; and 21.48 feet in length.

Practical Table of steam properties, by which to estimate the effects of the steam-engine, &c.

Force in lbs. per square inch above the atmosphere.	Temperature in degrees of Fahrenheite.	Increase of temperature required to produce the increase of force.	Volumes of steam produced from 1 of water.	Cubic inches of water to produce a cubic foot of steam.	Decimal equivalents for facilitating the calculations of boiler surface, &c.
2.5	220°	—	1496	1.14	.2507
3	222	2°	1453	1.18	.2581
4	225	5	1366	1.25	.2745
5	228	8	1282	1.33	.2925
6	231	11	1228	1.41	.3054
7	234	14	1174	1.47	.3194
8	236	16	1127	1.52	.3328
9	238	18	1084	1.58	.3459
10	240	20	1044	1.64	.3592
12	245	25	973	1.80	.3854
15	251	31	883	1.93	.4247
20	260	40	767	2.23	.4889
25	268	48	678	2.52	.5531
30	275	55	609	2.81	.6158
35	282	62	553	3.09	.6781
40	288	68	506	3.38	.7411
45	294	74	468	3.66	.8013
50	299	79	435	3.93	.8621
55	304	84	407	4.20	.9211
60	309	89	382	4.48	.9816

APPENDAGES TO BOILERS.

THE SAFETY VALVE.

A safety valve is properly a loaded circular disc covering an opening in the top or upper side of a steam boiler, for the purpose of prevention by escape any unnecessary or unsafe accumulation of steam in the boiler by the intensity of the fire whilst the engine is not at work, or otherwise.

Safety valves generally are loaded either directly or by the action of a lever with a weight or spring balance attached. When the weight is acting immediately upon the valve, without the intervention of a lever, the amount of weight in lbs., divided by the area of the valve in inches equal the direct pressure on each inch of the boiler; but if a lever is applied, the principle of the lever must be taken into account, and in practice the following various points of action and effect are the chief that require the particular notice of the practical engineer.

The lever being moveable round a pin as an axis at one end, and resting upon the valve as a fulcrum at some proportionate distance, tends to press down the valve less or more, according to the lever's length and general magnitude, the effect of which is designated the *action* of the lever upon the valve, the amount of which is very easily ascertained by simply attaching to the lever a spring balance by a piece of twine or otherwise, but immediately above the centre of the valve, and observing the index when gently lifted by hand, hence the amount of weight indicated, and added to the weight of the valve, are a constant quantity which must be subtracted or added, as the nature of the calculation may require.

Again, when a lever is applied to a valve where a weight is to be attached, the lever may be of any length whatever; but where a spring balance is to be applied, the lever ought to be of the following proportion—viz., the distance from the lever's centre of rotation to the centre of the valve equal the diameter of the valve, and the distance from the lever's centre of rotation to the spring balance as many times the diameter of the valve as there are square inches in its area; hence, the exact pressure upon each square inch of the boiler is always indicated by the spring balance, plus the action of the lever and weight of the valve.

To estimate properly the various amounts of effect by a lever and weight, or spring balance, acting upon a safety valve.

Suppose, for a general example, that the diameter of the valve = 6 inches, or 28.27 square inches area.

The required pressure per square inch = 12 lbs., or 339.24 lbs. total pressure on valve.

Length of lever 26½ inches.

Distance from centre of rotation to centre of valve 4 inches.

Action of lever and weight of valve together 9½ lbs.; then,

1. To find what weight will be required to produce that pressure at a given distance, say 19 inches from the centre of rotation.

$$\frac{339.24 - 9.5 \times 4}{19} = 69.4 \text{ lbs. suspended on the lever.}$$

2. When the weight to be placed upon the lever is given, and other peculiarities as above, to find at what distance from the centre of rotation, that weight must be placed to produce the pressure required.

$$\frac{339.24 - 9.5 \times 4}{69.4} = 19 \text{ inches distant from lever's centre of rotation.}$$

3. The weight, with its distance from the lever's centre of rotation being given, and also from the same point to the centre of the valve, to find what is the effective pressure at that point; action of lever and weight of valve included.

$$\frac{69.4 \times 19}{4} = 329.65 + 9.5 = 339.15 \text{ lbs. Total amount of pressure upon the valve.}$$

4. Suppose a spring balance attached at the end of the lever, (which in our present example is 26½ inches from the centre of rotation, other peculiarities as before,) and the tendency of the steam to raise the valve equal any given quantity, say 339.24 lbs. to find what weight ought to be indicated by the spring balance.

$$\frac{339.24-9.5\times4}{26.5}=49.772 \text{ lbs. indicated by the spring balance.}$$

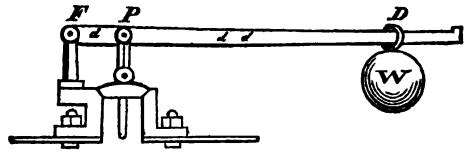
5. The total amount of force tending to raise a safety valve, also the distance of valve's centre to centre of lever's rotation being given, to find what length of lever is necessary to equipoise the required pressure, by a certain indicated weight upon the spring balance.

$$\frac{339.24-9.5\times4}{49.772}=26.5 \text{ inches, the distance between the spring balance and lever's centre of rotation.}$$

TO FIND THE PROPER DIAMETER FOR A SAFETY VALVE.

RULE.—Multiply the bottom surface of the boiler, or surface immediately exposed to the action of the fire, in feet, by the multiplier opposite to the pressure in lbs. on each square inch of the safety valve, and the square root of the product is the valve's diameter in inches at the narrowest part. If the boiler is to have two safety valves, then the square root of half the product equals the diameter of each.

Pressure in lbs. per square inch.	Multipliers.	Pressure in lbs. per square inch.	Multipliers.
3	.356	15	.315
4	.353	20	.305
5	.348	25	.293
6	.344	30	.289
7	.339	35	.282
8	.336	40	.275
10	.329	45	.270
12	.321	50	.264



NOTE.—In the above section of a valve with a lever, let F denote the fulcrum, P the whole pressure upon the valve, D the distance of the weight from F, d the distance between F and P, $d\,d$ the distance between F and D, W the weight upon the lever, and p the action of the lever upon the valve.

Then 1. $\frac{\overline{P-p} \times d}{d\,d} = W.$ 2. $\frac{\overline{P-p} \times d}{W.} = D.$

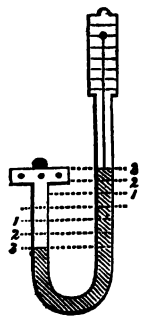
3. $\frac{W \times d\,d}{d} + p = P.$

THE STEAM GAUGE

Is an indicator of conspicuous reference, by which the density or force of steam in the boiler may be at all times ascertained, this being an object of the strictest importance, because, through laxity of attention, a vacuum might be formed in the boiler, or the steam might be of considerably greater elastic force than required, although escaping partially by the safety valve; hence the steam gauge is a general test for the regulation of the fire. Again, if by any means the safety valve become fastened, and a superabundant force of steam accumulated, the mercury may be driven out of the tube, by which extra indication is given, and ultimately the steam gauge become of itself a means of diminishing the force of the steam, in proportion to the dimensions or bore of the tube of which it is formed.

The common construction of a steam gauge is an inverted syphon, or bent tube of wrought iron, one end of which may be attached to the boiler or steam pipe to suit convenience, a hole having been previously made for the free emission of the steam to a counterpoise of

mercury for the purpose in the tube, the other end of which is open to the atmosphere; but the action of the column of mercury may appear more plain by means of the following section:



The steam depresses the mercury in the short tube, consequently causes it to rise in the longer one; 2 inches of mercury is a counterpoise to 1 lb. pressure of steam, therefore a rise of 1 inch in the long tube indicates a force equal to 1 lb. per square inch in the boiler.

A FLOAT

Is as requisite for ascertaining the height of the water in a boiler as a glass gauge is for the height of the steam, but can only be properly applied in a land or fixed engine boiler. The float may be of either *stone*, *iron*, *copper*, or any other body that will not be destroyed by the heat of the water or force of the steam; hence, a float may be made so heavy as to sink in the water, consequently a counterpoise is required; or it may be made so buoyant that it will neither be steady in the boiler, sink to the depth required, nor will it fall by its own gravity when the water is getting low, therefore additional weight must be attached, and in either case the float immersed about $\frac{2}{3}$ds of its thickness or depth.

RULE 1.—*When too heavy*, subtract the weight of the water displaced from the weight of the float; the remainder is the counterpoise required.

RULE 2.—*When too buoyant*, subtract the weight of the float from the weight of the water displaced; and the remainder is the weight that must be added to the float.

NOTE.—The weight must either be inside the float, or otherwise attached, clear of the surface of the water.

EXAMPLE 1.—Required the weight necessary to counterpoise a float of paving stone, 14 inches diameter, $2\frac{1}{4}$ inches thick, and immersed two-thirds of its thickness in fresh water;

say, the weight of stone and rod attached $= 30\frac{1}{2}$ lbs.

then, $\frac{14^2 \times .7854 \times 2.25 \times 2}{3} = 230.9$ inches of water displaced.

1 inch of water $= .03617$ lbs. avoirdupois; hence,

$230.9 \times .03617 = 8.35$ lbs. of water displaced, and $30.5 - 8.35 = 22.15$ lbs. required for a counterpoise.

EXAMPLE 2.—Suppose a float to consist of a concave copper ball, 12 inches diameter outside, and weigh with rod attached $7\frac{1}{4}$ lbs.; required the weight that must be added inside, so that the ball may remain immersed half its depth in fresh water.

$\frac{12^3 \times .5236 \times .03617}{2} = 16.36$ lbs. of water displaced,

and $16.36 - 7.25 = 9.11$ lbs. that must be added to the float.

GAUGE COCKS AND GLASS TUBES

Are intended to show the height of water in a boiler where a float cannot properly be applied, such as those of *marine and locomotive engines*, but require particularly strict attention under the following circumstances;—namely, *all new boilers, boilers immediately after being cleaned, and marine boilers in passing from fresh to salt*

water, or from salt to fresh, more especially water holding earthy and other matters in solution; in either case the water, when steam is up, becomes frequently in a state of complete fermentation, the boiler appears to contain more than a sufficient quantity of water, when in reality there may not be *solid* water, as it is termed, at the first cock, which ought not to be less than from three to four inches above the top of the highest flue. Putting a few pounds of tallow in a marine boiler, previous to getting up steam, or firing light, when fermentation, or *priming*, as it is frequently called, is likely to occur, are the usual modes of prevention; but the same applied to locomotive boilers, in many instances increase the fermentation in place of lessening it, and there is not any means, that I am aware of, that will prevent it efficiently, otherwise than by frequently blowing out, and by such means clear the boiler of every foreign substance that may have been deposited therein.

It must also be here impressed upon the mind of every individual to whom the care of a steam-engine is entrusted, the very great necessity of a constant sufficiency of water in the boiler, for a volume of steam suddenly formed is attended with considerably *greater danger* than an excess of steam regularly accumulated, as the safety valve will allow part to escape during its formation, and also give warning of its progression, but the valve cannot act so instantly and efficiently as is required if steam be suddenly generated, which, I have no doubt, is the case where some of the plates of a boiler are red hot when the engine is started, and if not the cause of an immediate *explosion*, may be the means of materially injuring the boiler, and render it incapable of withstanding, in safety, the pressure of steam required.

THE FEED PIPE AND FEED PUMP.

Boilers are supplied with water in two distinct forms, namely, by the gravity of the water alone, and by means of a force pump applied to the engine.

When a boiler is supplied by the gravity of the water, the pipe attached to the top of the boiler, containing the column of water, is designated the *feed pipe*, the one from the pump being only for the purpose of conveying the water to the top of the feed pipe, the height of which requires to be at least $2\frac{1}{2}$ feet above the surface of the water in the boiler for every pound pressure on a square inch of the safety valve.

To ascertain the capacity of the feed pump.

If the exact consumption and waste of steam, imperfections of the pump, leakages of the boiler, &c., could be properly ascertained, the pump's capacity could easily be determined, but this being impossible, its dimensions can only be regulated by being made sufficiently large not only to keep up the quantity of water which is constantly required, but also to be enabled to meet the greatest contingencies in all ordinary cases of the engine's working: hence observe the following

RULE.—Multiply the area of the piston in feet by its velocity, also in feet per minute, and by three times the quantity of water in a cubic foot of steam, at the required pressure in lbs. per square inch;—divide the product by the length of the pump's stroke in inches multiplied by the number per minute, and the quotient is the pump's area in inches. Or, divide the product by its area, multiplied by the number of strokes per minute, and the quotient is the length of stroke.

EXAMPLE 1.—Required the diameter of feed pump for an engine whose cylinder is 2 feet diameter, length of stroke 4 feet, and making 27 revolutions per minute, or the velocity of the piston equal 216 feet, the pressure of steam equal 4 lbs. per square inch, and the length of the pump's stroke equal 18 inches.

The quantity of water in a cubic foot of steam at 4 lbs. per square inch equal 1.25 cubic inches, *(see Table, page* 26,) and $1.25 \times 3 = 3.75$.

The area of a cylinder 2 feet diameter = 3.14.

$18 \times 27 = 486$. Hence $\frac{3.14 \times 216 \times 3.75}{486}$

= 5.23 inches area, or nearly 2.6 inches diam.

2.—Suppose the engine as above described, and existing under similar circumstances of velocity, pressure, &c., but the area of the pump given equal 5.23 inches, required the length of stroke.

$5.23 \times 27 = 141.21$. And $\frac{3.14 \times 216 \times 3.75}{141.21}$

= 18 inches length of stroke.

NOTE.—The suction and delivering pipes to any pump ought not to be less than two-thirds of the pump's diameter; and in the delivering pipe to the boiler, in high-pressure engines, particularly locomotives, a small *cock* should be inserted, so as to allow the steam and air which accumulates in the pipes to escape, otherwise the boiler is frequently prevented from being regularly supplied.

OF THE STEAM ENGINE GENERALLY.

Steam engine is a term of general application to all machines in which the steam or vapour of water is the motive power; hence, the usually familiar distinctions, namely, low pressure, or condensing engines; high pressure, or non-condensing; rotatory, which may be either the one or the other; and locomotives, in which steam of great density is required; but, although these distinctions be made for practical convenience, the principles of all are the same.

OF THE CYLINDER.

The cylinder, in whatever denomination of engine, is that in which the motion is produced. It is by the cylinder's capacity that the power of the engine is ascertained; and it is by the length of the stroke, in a great measure, that the piston's velocity is determined; hence, some of the various properties and proportions that cylinders and pipes bear in relation to each other may be

found useful in other respects, besides those immediately connected with the cylinder of a steam engine.

1. A cylinder in its diameter is the most capacious of all plain figures, or contains the greatest area within the same perimeter or outline.

2. The ratio of the diameter is to its circumference as 1 to 3.1416; twice the diameter contains twice the circumference; hence the piston of a large engine has less rubbing surface, or less friction, in proportion to its power, than a small one.

3. The areas of circles are to each other as the squares of their diameters, or as .7854 to 1′. A circle twice the diameter contains four times the area. Hence,

Suppose the circumference and area of a circle be required, the diameter of which is 20 inches.

$20 \times 3.1416 = 62.832$ inches circumference.
$20^2 \times .7854 = 314.16$,, area.

Again, suppose the circumference and area of a circle be required, the diameter of which is 40 inches.

$40 \times 3.1416 = 125.664$ inches, or twice 62.832.
And $40^2 \times .7854 = 1256.64$,, or four times 314.16.

The whole capacity of a cylinder equal the product of the area multiplied by the perpendicular height.

Because also, of all circles being in proportion to each other as the squares of their diameters, any number of smaller pipes may be made equal to one of the whole dimensions, and *vice versa*.

Thus, suppose the diameter of a pipe equal 8 inches, required the diameters of two pipes, that shall, united, be of equal area.

$8^2 = 64$ and $\sqrt{\frac{64}{2}} = 5.65$ inches, the diameter of each.

Or, 5.65^2 &c. $\times 2 = \sqrt{64} = 8$ inches.

Not unfrequently, a cylinder, or cylindrical vessel, is required whereby to contain the greatest cubical capacity, and bounded by the least possible superficial surface,—to compute which, observe the following

RULE.—Multiply the given capacity by 2.56, and the cube root of the product equal the diameter, and half the diameter is the depth, in equal terms of unity.

Thus, suppose a vessel of a cylindrical form be required, whose capacity shall equal 600 cubic feet, its bounding surface to be of the least possible dimensions.

$\sqrt[3]{600 \times 2.56} = 11.5379$ feet diameter.
And $11.5379 \div 2 = 5.76895$ „ depth.

Again, suppose the vessel is to be constructed with two ends, like that of a cylindrical boiler.

RULE.—Divide four times the required capacity by 3.1416, and the cube root of the quotient equal both the length and diameter, in equal terms of unity.

Thus, $\sqrt[3]{\frac{600 \times 4}{3.1416}} = 9.142$ feet in length, and also in diameter.

THE PISTON, AND ITS PROPER VELOCITY.

The velocity of an engine is properly understood as the space passed through by the piston in any given time, whereby to produce a maximum of useful effect; the shorter the stroke, practically, the greater the number of revolutions in any given time, but consequently of diminished power; and the longer the stroke, practically, the greater the velocity, and of course the greater the power, providing the steam can be constantly maintained at a sufficient density; hence, because to the varying purposes to which engines are being constantly applied, it is not of unfrequent occurrence that to the production of equally beneficial effects, when a short stroke must of necessity be introduced, to augment the cylinder's diameter, in order to compensate for diminished velocity.

To determine what is the proper velocity for the piston of a steam engine.

RULE.—Multiply the logarithm of that fraction of the stroke through which the dense steam has been ad-

mitted, by 2.3, to the product of which add 7; multiply the sum by the distance in feet the piston has travelled when the steam is cut off, and 120 times the square root of the product equal the proper velocity for the piston, in feet per minute.

EXAMPLE.—Suppose the steam to be cut off in a 6 feet stroke when the piston has travelled $\frac{1}{3}$rd of the length, required its proper velocity.

Common logarithm of $3 = 0.47712.1$

$2.3\times$

$= 1.0973783$

$.7\ +$

$= 1.7973783$

feet $2\times$

$\sqrt{3.5947566} = 1.89$ &c. $\times 120$

$= 226.8$ feet velocity per minute.

Table of nominal velocities at various lengths of strokes.

STATIONARY ENGINES.			MARINE ENGINES.			HIGH PRESSURE ENGINES.		
Length of stroke in ft. & in.	Number per minute.	Velocity in feet per minute.	Length of stroke in ft. & in.	Number per minute.	Velocity in feet per minute.	Length of stroke in ft. & in.	Number per minute.	Velocity in feet per minute.
1 9	46	161	2 0	42	168	1 0	80	160
2 0	42	168	2 3	39½	177¾	1 3	70	175
2 3	38	171	2 6	38	190	1 6	62	186
2 6	35	175	3 0	32	192	1 9	55	192½
2 9	32	176	3 3	29⅜	193⅜	2 0	50	200
3 0	30	180	3 6	27⅞	194¼	2 3	46	207
3 3	28½	185½	4 0	24½	196	2 6	42½	212½
3 6	27	189	4 3	23½	199⅜	2 9	39⅜	217¼
3 9	26	195	4 6	22⅜	202½	3 0	37	222
4 0	25	200	4 9	21½	204¼	3 3	35	228½
4 3	24	204	5 0	21	210	3 6	33	231
4 6	23	207	5 6	19½	214½	3 9	31	232½
5 0	21½	215	5 9	19	218¼	4 0	29½	236
5 6	20	220	6 0	18½	222	4 6	27	243
6 0	19	228	6 6	17¾	224¼	5 0	24¾	247½
7 0	17½	245	7 0	16⅝	231	5 6	23	253
8 0	16	256	7 6	15½	232½	6 0	22	254

These are to be considered as the velocities of engines having the application of their power in the usual form. Sometimes the motion is communicated by a lever or half beam, and having the power transmitted from somewhere between the fulcrum and the piston, or end of the lever, in which case the velocity of the piston must be increased proportionally in accordance with the following

RULE.—Multiply the velocities in the table by the length of the lever in feet between fulcrum and piston, and divide the product by the distance between the fulcrum and connecting rod, the quotient is the velocity of the piston in feet per minute.

EXAMPLE.—Suppose a marine engine of this description, with a $3\frac{1}{2}$ feet stroke, length of lever 11 feet, and the connecting rod attached $2\frac{1}{2}$ feet from the piston, required the piston's velocity.

By the table, a 3 feet 6 inches stroke $= 194\frac{1}{4}$ feet velocity per minute, and $11-3.5=8.5$; then $\frac{194.25 \times 11}{8.5} = 251.3$ feet, the velocity required.

Of the power or effect of an engine, in the usual form.

Expansibility or increase of bulk being one of the properties of steam, and of the utmost importance in the steam-engine, it is necessary, previous to the attaining an amount of its power, to premise by elucidation of the steam's expansive principles.

In the starting of an engine, the steam has to overcome the friction and inertia of the whole mass; but after being in motion the impetus it has acquired continues it in that state for a time, independently of the action of the steam, friction being only now to be overcome; hence if the steam continue to act as forcibly as at first, it will communicate additional motion to the piston, and will, therefore, perform its stroke with

accelerated velocity; but if the supply of steam is cut off at any part of the stroke, the remainder requires to be effected, partly by the impetus the piston has already acquired, and partly by the expansive property of the steam, its force becoming less just in proportion as the space it occupies increases, thus the motion is in a great measure equalized, the action of the steam in full strength sets it in motion, and the small and decreasing force requisite to continue the motion at a uniform rate is furnished by the expansion of that steam; and the advantage gained by thus economizing the steam increases, in proportion to its density, aud to its being sooner cut off.

To determine the amount of uniform elastic force by expansibility.

RULE.—Divide the length of the stroke in inches by the distance also in inches, that the dense steam has been admitted, and divide the force of the steam in lbs. per square inch by the quotient. Find the logarithm of the first quotient to which add 1; multiply the sum by the last quotient, and the product is the uniform force of the steam in lbs. per square inch.

EXAMPLE.—Let the greatest elastic force of steam in the cylinder of an engine equal 48 lbs. per square inch, and let it be cut off from entering the cylinder when the piston has moved $4\frac{1}{2}$ inches, the whole stroke being 18; required an equivalent force of the steam throughout the whole stroke.

$18 \div 4.5 = 4$, and $48 \div 4 = 12$.
Hyperbolic logarithm of $4 + 1 = 2.38629$.
Then, $2.38629 \times 12 = 28.635$ lbs. per square inch, of uniform elastic force.

NOTE.—The uniform force will be on the square, or circular inch, accordingly as the pressure on the piston is taken in square or circular inches.

Table of Hyperbolic Logarithms.

No.	Log.	No.	Log.	No.	Log.	No.	Log.
1¼	.2231435	5¾	1.7491998	15	2 7080502	33	3.4965075
1½	.4054651	6	1.7917594	16	2.7725887	34	3.5263605
1¾	.5596157	6¼	1.8325814	17	2.8332133	35	3.5553480
2	.6931472	6½	1 8718021	18	2 8903717	36	3.5835189
2¼	.8109302	6¾	1.9095425	19	2.9444389	37	3.6109179
2½	.9162907	7	1.9459101	20	2 9957322	38	3.6375861
2¾	1.0116008	7¼	1.9810014	21	3.0445224	39	3.6635616
3	1.0986123	7½	2.0149030	22	3.0910424	40	3 6888794
3¼	1.1186549	7¾	2.0476928	23	3 2354942	41	3.7135720
3½	1 2527629	8	2 0794415	24	3.1780538	42	3.7376696
3¾	1.3217558	8½	2.1420661	25	3.2188758	43	3.7612001
4	1.3862943	9	2.1972245	26	3.2580965	44	3.7841896
4¼	1.4469189	9½	2 2512917	27	3.2958368	45	3 8066624
4½	1.5040774	10	2 3025851	28	3.3322045	46	3 8286414
4¾	1.5581446	11	2.3978952	29	3.3672958	47	3 8501476
5	1.6094379	12	2.4849066	30	3.4011973	48	3.8712010
5¼	1.6582280	13	2.5649493	31	3.4339872	49	3 8918203
5½	1.7047481	14	2.6390573	32	3.4657359	50	3.9120230

To determine the proper diameter of a cylinder for an engine of a required power; Or, to ascertain the power of an engine having a cylinder of a given diameter.

RULE 1.—Multiply 33,000 by the number of horses' power required, and divide the product by the piston's velocity in feet per minute, multiplied by the uniform force of the steam per circular inch, minus 7.85 lbs., and the square root of the quotient equal the cylinder's diameter in inches.

2.—Multiply the square of the cylinder's diameter in inches, by the uniform force of the steam in lbs. per circular inch, minus 7.85 lbs., and by the velocity of the piston in feet per minute; divide the product by 33,000, and the quotient is the amount in horses' power that the engine is equal to.

EXAMPLE 1.—Required the diameter of the cylinder for a condensing engine of 14.4 horses' power, and also the weight on each square inch of the safety valve, in

order to produce steam of 13.37 lbs. uniform elastic force, the steam to be cut off from the cylinder when the piston has moved through 32 inches of its stroke, velocity of the piston 216 feet per minute, resistance and friction 7.85 lbs. per circular inch, or 5.52 lbs. of effective, or uniform force, hence—

$$\frac{33000 \times 14.4}{216 \times 5.52} = \frac{475200}{1192} = \sqrt{400} = 20 \text{ inches diameter.}$$

Again,—Suppose the stroke equal 4 feet, or 48 inches, $-48 \div 32 = 1.5$, and hyperbolic logarithm of $1.5 = 0.40546$, to which add 1, $= 1.40546$; then, $\frac{13.37 \times 1.5}{1.40546}$ $= 14.28$ lbs., the total force of steam in the boiler per circular inch; and 14.28—11.78, or mean pressure of the atmosphere $= 2.5$ lbs. effective elastic force or weight upon each circular inch of the safety valve.

EXAMPLE 2.—Suppose it be required to ascertain the effective power of a condensing engine, the following particular requisites of estimation being given, namely, cylinder, 20 inches in diameter; stroke 4 feet, or 216 feet velocity per minute; weight on each circular inch of the safety valve $2\frac{1}{2}$ lbs, or 14.28 lbs., atmospheric pressure included; steam cut off from the cylinder when the piston has passed through 32 inches of its stroke; resistance and friction 7.85 lbs. per circular inch; what is the useful effect of the engine in horses' power.

$48 \div 32 = 1.5$ and $14.28 \div 1.5 = 9.52$.—The hyperbolic logarithm of 1.5 plus 1. $= 1.40546 \times 9.52$ $= 13.37$ lbs. per circular inch of uniform elastic force, and $13.37 - 7.85 = 5.52$ lbs. of effective force; hence,

$$\frac{20^2 \times 5.52 \times 216}{33000} = \frac{476928}{33000} = 14.4 \text{ horses' power.}$$

NOTE.—Condensing engines are governed in a great measure by the amount of vacuum obtained, the mercury in the barometer

attached to the condenser ranging between 24 and 28¼, or at an average of 26¼ inches; hence, the mean pressure of the atmosphere being 14.7 lbs. per square inch, and equal to a column of mercury 30 inches in height,—30 : 14.7 :: 26.25 : 12.86 lbs. and 14.7 —12.86 = 1.84 or nearly 2 lbs. per square inch remaining under, or acting as a resistance to the piston, besides 8 lbs. per square inch, by which to overcome the friction and inertia of the engine, making the total about 10 lbs. per square inch, or 7.85 lbs. per circular inch on the piston.

In high pressure or non-condensing engines the resistance and friction remain nearly a constant quantity, viz. 18 lbs. per square inch, or 14.1 lbs. per circular inch, including the resistance of the atmosphere.

By an indicator, I am perfectly aware that the above quantities for resistance and friction in a well constructed engine would be found too much; but as the contention generally lays on the purchasing side, it is considered better to let the rules remain so, and if disagreement should still exist, decide by the indicator.

EXAMPLE 3.—What is the power of a non-condensing engine, having a cylinder of 9 inches diameter, a stroke of 2 feet, or 200 feet velocity per minute, and a pressure of steam in the boiler of 40 lbs. per square inch, atmospheric pressure included, the steam to be stopped off from the piston at half stroke, and the resistance, friction, &c. 18 lbs. per square inch, or 14.1 lbs. per circular inch on the piston's area?

40 lbs. per square inch = 31.4 lbs. per circular inch,

$\frac{24}{12} = 2$, and $\frac{31.4}{2} = 15.7$, The hyperbolic logarithm of 2 plus 1 = 1.693 × 15.7 = 26.6 lbs. uniform force of the steam per circular inch, and 26.6 — 14.1 = 12.5 lbs. effective force on each circular inch of the piston;

hence, $\frac{9^2 \times 12.5 \times 200}{33000} = 6.1$ horses' power.

EXAMPLE 4.—Let it be required to construct a non-condensing engine of 6.1 horses' power, the uniform elastic force of steam to be 26.6 lbs. per circular inch

in the cylinder, when cut off—at half stroke, piston's velocity 200 feet per minute, resistance and friction 14.1 lbs. per circular inch; required the cylinder's diameter in inches, and also the pressure of the steam on each circular inch of the boiler above the pressure of the atmosphere.

26.6 lbs. elastic force, minus 14.1 resistance and friction, = 12.5 lbs. effective pressure per circular inch; hence,

$$\sqrt{\frac{33000 \times 6.1}{200 \times 12.5}} = 9 \text{ inches diameter.}$$

Again, $\frac{24}{12} = 2$, The hyperbolic logarithm of 2 plus 1 = 1.693, and $\frac{26.6 \times 2}{1.693} = 31.4 - 11.78 = 19.62$ lbs. per circular inch, or 25 lbs. per square inch in the boiler above the pressure of the atmosphere.

The preceding may be taken as the real effect of an engine, expressed in the usual term, *horses' power;* but, there exist various nominal and approximate rules, whereby the diameter of a cylinder, or power of an engine, is determined, but governed in a great measure by competition,—one maker endeavouring to excel another, by increasing the effect of the engine and retaining the same nominal power, which is not unfrequently supposed the result of superior mechanism, or some very essential interior intricacy, although, generally, at the expense of a larger cylinder, or an increased force of steam.

However, the following are selected as those most commonly used, and what custom has rendered almost a general standard, the more so, no doubt, on account of being considered to have emanated originally from the celebrated firm of Boulton and Watt.

In this rule the steam in the boiler is supposed at a constant pressure of about 3.18 lbs. per square inch, or 2.5 per circular inch; the piston at a constant or uniform velocity of 220 feet per minute; and the effective force on the piston about 7.5 lbs. per square inch, or 5.89 lbs. per circular inch; and under such circumstances 30 circular inches are considered an equivalent to one horse power, when the beam for communicating the motion from the piston is about 3, and the connecting rod not less than 2.5 times the length of stroke.

But marine engines are generally confined, the connecting rods being seldom more than from 1.75 to twice the length of stroke, and, as a compensation for this disadvantage, the area of the piston is augmented to 31.5 circular inches to each horse power.

Again, small packets for rivers, &c., are still more confined, being often compelled to have the connecting rods not more than from 1.25 to 1.5 times the length of stroke, causing a very acute angle with the crank; in such, not fewer than 34 circular inches is considered equal to one horse power.

In high-pressure, or non-condensing engines, one-third the force of the steam is deducted for friction, resistance of the atmosphere, &c.; hence, as in condensing engines, $30 \times 5.89 = 176.7$ lbs. effective pressure equal the amount of one horse power; consequently, steam at 25 lbs. per square inch, or 19.63 lbs. per circular inch, minus $\frac{1}{3}$rd, $= \frac{19.63 \times 2}{3} = 13.08$ lbs effective pressure on each circular inch of the piston's area, and $176.7 \div 13.08 = 13.6$ circular inches to each horse power.

Steam at 30 lbs. per square inch $= 23.56$ lbs. per circular inch, and $\frac{23.56 \times 2}{3} = 15.7$ lbs. effctive pressure;

hence, $176.7 \div 15.7 = 11.3$ circular inches to each horse power.

Steam at 40 lbs. per square inch = 31.41 lbs. per circular inch, and $\frac{31.41 \times 2}{3} = 20.94$ lbs. effective pressure; hence $176.7 \div 20.94 = 8.5$ circular inches to each horse power.

Steam at 50 lbs. per square inch = 39.27 lbs. per circular inch, and $\frac{39.27 \times 2}{3} = 26.18$ lbs. effective pressure; hence, $176.7 \div 26.18 = 6.8$ circular inches to each horse power;—and the same at any other pressure that might be required.

Ex. 1.—Required the diameter of a cylinder for a stationary condensing engine of 36 horses' power.

$$\sqrt{36 \times 30} = 32.86 \text{ inches diameter.}$$

Ex. 2—What is the nominal power of an engine, the cylinder of which is 32.86 inches diameter?

$$32.86^2 \div 30 = 36 \text{ horses' power.}$$

Ex. 3.—Required the diameter of the cylinder for a marine engine of 65 horses' power.

$$\sqrt{65 \times 31.5} = 45.25 \text{ inches diameter.}$$

Ex. 4.—The diameter of the cylinder of a marine engine is 45.25 inches diameter; required the nominal power of the engine.

$$45.25^2 \div 31.5 = 65 \text{ horses' power.}$$

Ex. 5.—The force of the steam in a boiler is 30 lbs. per square inch above the pressure of the atmosphere; if it were applied to a non-condensing engine, so as to produce a power equal to 6 horses, what must be the cylinder's diameter?

$$\sqrt{11.3 \times 6} = 8.25 \text{ inches diameter.}$$

Ex. 6.—The diameter of the cylinder of a non-condensing engine is 8.25 inches, and the steam at 30 lbs. per square inch, required the engine's power.

$8.25^2 \div 11.3 = 6$ horses' power.

A Table of the Comparative elastic force of steam on a square or circular inch of a safety valve.

Steam with an elastic force of	lbs. on a square inch, equal	lbs. on a circular inch, and require to be maintained at a temperature of	Steam with an elastic force of	lbs. on a circular inch, equal	lbs. on a square inch, and require to be maintained at a temperature of
2.5	1.96	220°F	2.5	3.18	222.5°F
3	2.35	222	3	3.82	224.5
3.5	2.75	223.5	3.5	4.45	226.5
4	3.14	225	4	5.09	228.5
4.5	3.53	227	4.5	5.73	230.5
5	3.92	228	5	6.36	232
5.5	4.32	230	5.5	7.00	234
6	4.71	231.5	6	7.64	235.5
6.5	5.10	233	6.5	8.27	236.5
7	5.49	234	7	8.91	238.5
7.5	5.89	235	7.5	9.55	239.5
8	6.28	236	8	10.18	241
9	7.06	239	9	11.45	244
10	7.85	240	10	12.73	247
12	9.42	245.5	12	15.27	252.5
15	11.78	251	15	19.09	259
20	15.71	260	20	25.46	270
25	19.63	268	25	31.83	278.5
30	23.56	275	30	38.19	287
35	27.49	282	35	44.56	294
40	31.41	288	40	50.92	300.5
45	35.34	294	45	57.20	305
50	39.27	299	50	63.66	309

The preceding questions are very conveniently computed by means of the sliding rule.

1. *By the engineer's improved sliding rule.*—Set 1 upon B to the number of circular inches allowed to a horse power upon A, and against the number of horses' power upon C is the cylinder's diameter in inches upon D; Or, against the cylinder's diameter in inches upon D is the number of horses' power upon C.

Thus, set 1 upon B to 30 upon A, and against any number of horses' power upon C is the diameter in inches upon D, for common condensing engines.

2. *By the common sliding rule.*—Set 1 upon C to the

diameter of a cylinder equal to 1 horse power upon D, and against any diameter upon D is the number of horses' power upon C; Or, against any number of horses' power upon C is the diameter of the cylinder in inches upon D.

NOTE.—The square root of *any number* of circular inches to a horse power equal *the diameter;*—thus $\sqrt{30}=5.47$ inches,—$\sqrt{31}=5.6$ inches,—$\sqrt{34}=5.8$ inches, being the diameters of cylinders of 1 horse power, for land and marine condensing engines; And $\sqrt{13.6}=3.7$ inches,—$\sqrt{11,3}=3.4$ inches,—$\sqrt{8.5}=2.9$ inches,—and $\sqrt{6.8}=2.6$ inches, or the diameter of cylinders for non-condensing engines of 1 horse power, with steam above the pressure of the atmosphere equal to 25, 30, 40, and 50 lbs. per square inch.

Ex. 1.—What diameter must a cylinder be for a condensing engine to equal 20 horses' power?

Set 1 upon B to 30 upon A, and against 20 upon C is 24½ upon D.

When the rule is thus set, C is a line of horses' power, and D a line of diameters for cylinders corresponding to that power.

Ex. 2.—What number of horses' power will a high pressure engine be equal to when the cylinder is 12 inches diameter, and steam 30 lbs. per square inch?

Set 1 on B to 11.3 upon A, and against 12 upon D is 12.7 horses' power upon C.

Suppose the same to be required upon the common slide rule,

1.—Set 1 upon C to 5.47 upon D, and against 20 upon C is 24½ upon D.

2.—Set 1 upon C to 3.4 upon D, and against 12 upon D is 12.7 upon C.

Table of the diameters of Cylinders for Steam Engines of Nominal horse's power.

STATIONARY CONDENSING ENGINES.			MARINE ENGINES.			HIGH PRESSURE, OR NON-CONDENSING ENGINES.				
Nominal Horse's Power.	Diameter of Cylinders in Inches.	Length of Strokes in Feet.	Nominal Horse's Power.	Diameter of Cylinders in Inches.	Length of Strokes in Feet.	Nominal Horse's Power.	Diameters of Cylinders in inches the force of the steam being, per square inch,			
							25 lbs.	30 lbs.	40 lbs.	50 lbs.
2	9	1¾	10	20	2	1	3⅜	3⅛	3	2⅝
3	11	2	12	21¼	2	1½	4⅛	4⅜	3⅝	3¼
4	12	2¼	15	23⅝	2¼	2	5¼	4⅝	4¼	3¾
5	13½	2⅜	16	24½	2¼	2½	5¾	5⅛	4⅝	4¼
6	14¾	2½	18	25¾	2⅜	3	6⅛	6	5	4⅜
8	16½	3	20	26¾	2⅝	3½	6¾	6⅛	5½	4¾
10	18	3¼	25	28⅝	3	4	7⅛	6⅝	6	5¼
12	19½	3⅜	30	31⅛	3	4½	7¾	7⅛	6½	5⅝
14	21	3⅝	35	33⅛	3¼	5	8¼	7½	6⅝	5¾
15	21⅛	3¾	40	36¼	3¼	5½	8¾	7¾	6¾	6¼
16	22	4	45	37⅛	3⅜	6	9	8¼	7⅛	6⅜
18	23	4¼	50	39⅛	3⅜	6½	9¼	8⅜	7	6⅝
20	24½	4⅜	55	40⅜	4	7	19¾	9	7¾	6¾
22	25¼	4½	60	43	4	7½	10	9¼	8	7¼
24	26¼	4⅝	65	44	4	8	10¼	9⅜	8¼	7⅜
25	26¾	5	70	46	4¼	8½	10⅜	9½	8⅜	7⅝
26	27	5	75	46¾	4⅜	9	11¼	10¼	8¾	7⅞
28	27⅛	5¼	80	48	4⅜	10	11¾	11	9⅛	8¼
30	28¼	5⅜	85	49	4½	11	12¼	11⅜	9¾	8½
35	30⅜	5½	90	50	4½	12	13	12	10⅛	9¼
40	32⅜	6	95	52	4½	13	13½	12½	10⅞	9⅝
45	34½	6	100	52½	5	14	14	12⅞	11¼	10
50	36	6¼	110	55	5	15	14⅝	13⅜	11⅝	10½
55	37⅛	6½	115	56½	5	16	15	13¾	12	10¾
60	39	6¾	120	57	5⅛	17	15½	14	12⅛	10¾
65	40½	6¾	125	58	5⅛	18	15¾	14½	12⅝	11¼
70	41⅝	7	130	59	5⅛	19	16¼	14¾	13¼	11⅝
75	43	7	135	60	5⅜	20	16⅝	15¼	13⅝	11⅞
80	44	7⅛	140	61	5½	25	18½	17¼	15	13¼
85	45½	7⅜	145	62	5½	30	20¼	19⅛	16½	14¼
90	46	8	150	62⅛	6	35	21⅝	20¼	17¼	15⅛
95	47½	8	175	67⅛	6	40	23	21⅝	18⅝	16¼
100	48⅝	8	200	71⅛	6½	Quantity of water for feed, in gals. per minute to each horse power, equal		.45	.5	.61 .73
110	51	8	250	79⅛	6½					

Of the Steam Engine Indicator, its application, &c.

The properly effective power of an engine to any degree of exactitude can only be ascertained through

the medium of an indicator; that is, an instrument by means of which the effective force of the steam on the piston and extent of vacuum in the cylinder may at all times be equally exhibited. In peculiarity of construction it is simply a small cylinder truly bored, and into which a piston is inserted and loaded by a spring of suitable elasticity to the graduated scale thereon attached.

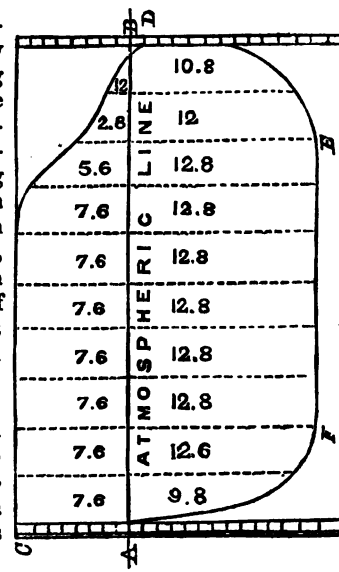
The action of an indicator is that of describing on a piece of paper attached, a diagram or figure approximating more or less to that of a rectangle, varying of course with the merits or demerits of the engine's productive effect. The breadth or height of the diagram is the sum of the force of the steam and extent of the vacuum; the length being the amount of revolution given to the paper during the piston's performance of its stroke.

To render the indicator applicable it is commonly screwed into the cylinder cover, and the motion to the paper obtained by means of a sufficient length of small twine attached to one of the radius bars; but such application cannot always be conveniently effected, more especially in engines on the marine principle, hence, other parts of such engines, and other means whereby to effect a proper degree of motion, must unavoidably be resorted to. In those of direct action the cross head is the only convenient place of attachment; but because the length of the engine's stroke is considerably more than the movement required for the paper on the indicator, it is necessary to introduce a pulley and axle, by which means the various movements are qualified to suit each other.

When the indicator is fixed and the movement for the paper properly adjusted, allow the engine to make a few revolutions previous to opening the cock; by which means a horizontal line will be described upon the paper by the pencil attached, and denominated the atmo-

spheric line, because it distinguishes between the effect of the steam and that of the vacuum. Open the cock, and if the engine be upon the descending stroke, the steam will instantly raise the piston of the indicator, and by the motion of the paper with the pencil pressing thereon, the top side of the diagram will be formed.—At the termination of the stroke and immediately previous to its return, the piston of the indicator is pressed down by the surrounding atmosphere, consequently the bottom side of the diagram described, and by the time the engine is about to make another descending stroke, the piston of the indicator is where it first started from, the diagram being completed; hence is delineated the mean elastic action of the steam above that of the atmospheric line, and also the mean extent of the vacuum underneath it.

But in order to elucidate more clearly, by example the following diagram, taken by one of M'Naught's indicators from a marine engine, the steam being cut off after the piston had passed through two-thirds of its stroke, the graduated scale on the indicator tenths of an inch, as shown at each end of the diagram annexed.



Previous to the cock being opened, the atmospheric line A B was formed, and when opened the pencil was

instantly raised by the action of the steam on the piston to C, or what is generally termed the *starting corner;* by the movement of the paper and at the termination of the stroke the line C D was formed, showing the force of the steam and extent of expansion; from D to E show the moments of eduction; from E to F the quality of the vacuum; and from F to A the lead or advance of the valve; thus every change in the engine is exhibited, and every deviation from a rectangle, except that of *expansion* and *lead* of the valve show the extent of proportionate defect. Expansion produces apparently a defective diagram, but in reality such is not the case, because the diminished power of the engine is more than compensated by the saving in steam. Also the lead of the valve produces an apparent defect, but a certain amount must be given, as being found advantageous to the working of the engine, but the steam and eduction corners ought to be as square as possible; any rounding on the steam corner show a defect from want of lead; and rounding on the eduction corner that of the passages or apertures being too small.

To compute the power of an Engine from the Indicator Diagram.

RULE.—Divide the diagram in the direction of its length into any convenient number of equal parts, through which draw lines at right angles to the atmospheric line, add together the lengths of all the spaces taken in measurements corresponding with the scale on the indicator, divide the sum by the number of spaces, and the quotient is the mean effective pressure on the piston in lbs. per square inch.

Let the result of the preceding diagram be taken as an example. Then, the whole sum of vacuum spaces

$=1220 \div 10 = 12.2$ lbs. mean effect obtained by the vacuum; and in a similar manner the mean effective pressure of steam is found to be 6.28 lbs., hence the total effective force = 18.48 lbs. per square inch. And supposing 2.5 lbs. per square inch be absorbed by friction, What is the actual power of the engine, the cylinder's diameter being 32 inches, and the velocity of the piston 226 feet per minute?

$18.48 - 2.5 = 15.98$ lbs. per square inch of nett available force.

Then $\frac{32^2 \times .7854 \times 15.98 \times 226}{33000} = 88$ horses' power.

The line under the diagram and parallel to the atmospheric line is $\frac{1}{10}$ths distant, and represents the perfect vacuum line, the space between showing the amount of force with which the uncondensed steam or vapour resist the ascent or descent of the piston at every part of the stroke.

As the mean pressure of the atmosphere is 15 lbs. per square inch, and the mean specific gravity of mercury 13560, or 2.037 cubic inches equal 1 lb., it will of course rise in the barometer attached to the condenser about 2 inches for every lb. effect of vacuum, and as a pure vacuum would be indicated by 30 inches of mercury, the distance between the two lines shows whether there is or is not any amount of defect, as sometimes there is a considerable difference in extent of vacuum in the cylinder to that in the condenser.

THE CONDENSER, COLD WATER PUMP, AIR PUMP, &c.

When steam is exposed to any degree of cold, its heat is abstracted, its elastic force diminished, and, in proportion to the intensity or quantity of cold, is sooner or later destroyed by condensation, re-assuming its former state as water, by which it is reduced in bulk

nearly 2000 times; hence its peculiar and advantageous properties in that of the condensing engine.

The usual mode of affecting condensation, whereby to produce a vacuum in the steam engine, is by an intermixture of the steam with that of cold water in a vessel conveniently communicating with the eduction valve from the cylinder, the vessel being so sufficiently formed as to defy any admission of atmospheric air, otherwise than what may be carried in by the steam and by the water, through which condensation of the steam is to be accomplished.

Water is found invariably to contain atmospheric air, and not unfrequently carbonic acid and other gases, which are not destroyed, but merely separated by the caloric or heat necessary to the formation of steam, and with it are carried into the cylinder; hence the propriety of the Air pump, by which to remove the heated vapours that would thus accumulate in the cylinder to impede the piston's motion, and also to remove the water from the condenser, after its having performed the duty of destroying by absorption the calorific properties of the steam.

The capacity of the condenser ought to be as large as circumstances will conveniently admit, and certainly not less than one-eighth the capacity of the cylinder; and it ought to be particularly observed in those of marine engines, that where the bottom of condenser and bottom of cylinder are nearly on the same line, care be taken in making the passage between the valves and condenser sufficiently large to contain the condensing water for one stroke of the piston, besides leaving ample communication, otherwise the connexion between the cylinder and air pump will be cut off by water of nearly 100° of heat, on account of the cylinder being twice filled with steam for each effective stroke of the air pump.

To produce the greatest amount of effect in an

engine, the condensed water ought not to exceed in temperature 100° Faht., and to obtain which requires about 30 cubic inches of water, at a mean of temperature for every cubic foot of steam at 220°, to which point it is generally reduced by expansion; but, because of imperfections, uncertainty of temperature, &c., an addition of $\frac{1}{8}$th, or 35 cubic inches, is the quantity by which to estimate the dimensions of the cold water pump; hence is deduced the following rule.

Divide 90 times the cubical capacity of the cylinder in feet by the pump's length of stroke in inches, and the square root of the quotient equal the diameter of the pump in inches. Or, divide the quotient by the square of the pump's diameter in inches, and the quotient equal the length of stroke.

EXAMPLE.—What diameter of pump is necessary for an engine with a cylinder of 30 inches, or $2\frac{1}{2}$ feet diameter, stroke 6 feet, and the stroke of the pump to equal half the stroke of the engine, or 36 inches?

Area of cylinder $= 4.9$ square feet.

Then, $\frac{4.9 \times 6 \times 90}{36} = \sqrt{\frac{2646}{36}} = 8.5$ inches diameter.

Or, $\frac{2646}{8.5^2} = 36$ inches, length of stroke.

The capacity of the Air pump is governed in a great measure by the temperature of the water that can be procured for condensation; in some land engines, where water in the locality is scarce, it has of necessity to be used over and over continually; in others of the same description, water can be obtained at a very low degree of temperature, consequently a pump of less capacity is required. Water for like purposes in marine engines is of less fluctuation in temperature; but another matter of contention arise instead, namely, when the paddle wheels are in an instant brought to a greatly reduced

velocity by the shock of a sea, during which time the rush of water into the condenser is not lessened, but becomes considerably accumulated for the next or following stroke of air pump bucket; hence it will be observed that, in practice, little more than approximation can be laid down as a general rule.

To find the proper quantity of water for condensation of steam at a given temperature, the temperatures of the condensing and condensed waters being given.

RULE.—To 1000 add the temperature of the steam, and from the sum subtract the temperature of the condensed water: divide the remainder by the temperature of the condensed water, minus the temperature of the condensing water, and the quotient is the number of times that the quantity for condensation must exceed that from which the steam is formed.

EXAMPLE.—Required the ratio or quantity of water for condensation to 1 of water for the formation of steam, the temperature of the condensing water being 45°, the steam 225°, and that of condensed water 110°.

$$\frac{1000 + 225 - 110}{110 - 45} = \frac{1115}{65} = 17 \text{ times the quantity.}$$

To estimate for the capacity of Air pump, in accordance with common practice.

RULE.—Divide the capacity of the steam cylinder in circular inches by 4 or 5 times, (as necessity may require,) the stroke of air pump also in inches, and the square root of the quotient equal the pump's diameter for land engines. For marine engines take six times the air pump's stroke for a divisor.

EXAMPLE 1.—Required the diameter of an air pump for a land engine, the cylinder of which to be 20 inches diameter, the length of stroke 4 feet or 48 inches, the

stroke of the pump to be half that of the piston, and the divisor to be five times the air pump's stroke.

$$\frac{20^2 \times 48}{5 \times 24} = \sqrt{\frac{19200}{120}} = 12.649 \text{ inches diameter.}$$

EXAMPLE 2.—Suppose it be found that a marine engine, with a cylinder of 36 inches diameter, and stroke of $3\frac{1}{2}$ feet, require an air-pump 20.78 inches diameter, when the stroke of the pump is half that of the piston, but the pump having of necessity to be placed 3 inches farther from the centre of the beam or side lever, required the length of stroke when there situated, and also the diameter, to be that of an equal capacity, to the given diameter at half the stroke of the piston, the beam or levers having a radius of 5 feet, or 60 inches.

The studs for working the pump being placed 3 inches further out than half stroke, of course gives a radius of 33 inches. And as 60:42::33:23.1 inches length of stroke. Hence,

$$\frac{36^2 \times 42}{23.1 \times 6} = \sqrt{\frac{54432}{138.6}} = 19.82 \text{ inches diameter.}$$

OF THE SLIDE VALVE, ECCENTRIC, &c.

The slide valve in a steam engine is a well known contrivance by which, in conjunction with the eccentric, a continuous reciprocating movement of the piston in the cylinder is effected by the alternate admission and eduction of the steam, the principal observations and calculations connected therewith being the following:—

1. *To determine what extent of lap or cover is necessary on the steam side of a slide valve, so as to cut the steam off at any required point of the stroke.*

RULE.—Divide by the length of the piston's stroke in inches the distance the piston has to travel when the steam is cut off; multiply the square root of the quo-

tient by half the stroke of the valve, also in inches, and from the product deduct half the lead, the remainder is the lap or cover required.

EXAMPLE.—Suppose an engine, the piston of which to have a stroke of 3 feet or 36 inches, and the steam to be cut off when the piston has moved through 23.4 inches, the travel of the valve being 5 inches, and the lead $\frac{1}{4}$ of an inch, what is the lap or cover required?

$36 - 23.4 = 12.6$ inches, the distance the piston has to travel,

And, $\sqrt{\frac{12.6}{36}} = .5916 \times 2.5$ being half the travel of valve $= 1.479 - .125$,

or half the lead, $= 1.354$ inches, the lap or cover required.

2. *To find at what point of the stroke the steam will be cut off by a given lap of valve.*

RULE.—To the lap of the valve on the steam side in inches add half the lead, divide the sum by half the travel of the valve, multiply the square of the quotient by the piston's stroke in inches, and the length of the stroke, minus the last product, equal the distance the piston will have travelled when the steam is cut off.

EXAMPLE.—Let the last example be reversed.

Lap of valve 1.354 inches, half of lead .125 inches, and stroke of piston 36 inches; hence

$\frac{1.354 + .125}{2.5} = 1.479^2 \times 36 = 12.6$ and $36 - 12.6 = 23.4$ inches the piston has travelled when the steam is cut off.

3. *To determine a proper amount of lead for the slide valve of a steam engine.*

RULE.—Multiply the square of the cylinder's diameter in inches, by the number of revolutions made

by the crank shaft per minute; cut off from the right hand of the product four figures for decimals; divide the remainder by the length of the steam aperture in inches, and the quotient is the lead in inches that ought to be given to the valve.

EXAMPLE.—Suppose an engine with a cylinder of 30 inches in diameter, number of revolutions per minute, 19, and the length of steam aperture 12 inches.

$30^2 \times 19 = 17100$, and with four figures pointed off for decimals is $\frac{1.7100}{12} = .142$ parts of an inch, the lead required.

NOTE.—The travel of a slide valve equal the width of the two steam openings, plus the lap of the valve over each opening, and the length it will cover, by its movement on the cylinder, equal twice the travel of the valve, plus the distance between the two steam openings.—Observe also, that the apertures for condensing engines ought to be about $\frac{1}{15}$th, and for non-condensing engines $\frac{1}{17}$th of the square of the cylinder's diameter, and in all cases, as much of the area in the length as can be practically admitted.

To determine the various peculiarities of throw, travel, &c., that exist between an eccentric and slide valve, when levers intervene.

1. When the travel of the valve, the length of the lever to which the eccentric rod is attached, and the length of the lever by which motion is communicated to the valve, being given, to find the proper amount of eccentricity for the camb, or throw of eccentric.

RULE.—Multiply the travel of the valve by the length of the lever to which the eccentric rod is attached, and divide the product by the length of the lever for communicating motion to the valve, and the quotient is the throw of eccentric.

2. When the travel of the valve, the length of the lever to which the eccentric rod is attached, and also

the throw of eccentric is given, to find what must be the length of the lever for immediate communication with the valve.

RULE.—Multiply the travel of the valve by the length of the lever to which the eccentric rod is attached, and divide the product by the throw of eccentric, the quotient is the length of lever required.

3. When the throw of eccentric, length of lever for immediate communication with the valve, and travel of valve is given, to find the length of the lever to which the eccentric rod is attached.

RULE.—Multiply the throw of eccentric by the length of the lever in immediate connexion with the valve, and divide the product by the travel of the valve, the quotient is the length of lever to which the eccentric rod is attached.

4. When the throw of eccentric, and the lengths of both levers are given, to find the travel of the valve.

RULE.—Multiply the throw of eccentric by the length of the lever which is in immediate connexion with the valve, divide the product by the length of the lever to which the eccentric rod is attached, and the quotient equal the travel of the valve.

NOTE.—It must be observed that all the dimensions are in equal terms of unity, that is, if one dimension be taken in inches, all the others must also be in inches, or, if one is taken in feet, so must all the others be in feet, &c.

Then, suppose for a general example,

The travel of the valve.....	=	8 inches
Length of lever attached to eccentric rod	=	6 ,,
Length of lever in connexion with valve	=	12 ,,
Throw of eccentric	=	4 ,,

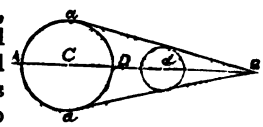
$$\frac{8 \times 6}{12} = 4 \text{ inches, throw of eccentric.}$$

$\frac{8 \times 6}{4} = 12$ „ length of lever in connexion with valve.

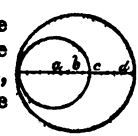
$\frac{4 \times 12}{8} = 6$ „ length of lever attached to eccentric rod.

$\frac{4 \times 12}{6} = 8$ „ travel of valve.

The throw of an eccentric, the travel of the valve, also the length of any one lever being given, to find the length of the other geometrically.

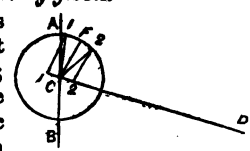


On any right line, as A B, describe a circle, A D, equal to the throw of eccentric and travel of valve, then from C as a centre, with a radius equal to the length of lever given, cut the line A B as at *d*, on which describe a circle equal to the throw of eccentric or travel of valve, as may be required; draw the tangents B *a*, B *a*, cutting each other in the line A B, and *d* B is the length of the lever as required.



The throw of an eccentric is equal to the sum of twice the distance between the centres of formation and revolution, as *a b*, or to the degree of eccentricity it is made to describe, as *c d*.

To find the proper position for an eccentric, in relation to the crank of a steam engine, the angle of eccentric rod and travel of the valve being given.



Draw the right line A B, as the situation of the crank at commencement of the stroke; draw also the line C D, as the proper given angle of eccentric rod with the crank; then from C as centre, describe a circle equal to the travel of the valve; draw the line C F, at right angles to the line C D, draw also the lines 1, 1, and 2, 2, parallel to the

line C F, and at a distance equal to the lap and lead of the valve, draw the angular lines C 1, C 2, which are the the angles of eccentric with the crank, for forward or backward motion, as may be required.

NOTE.—The lap of the valve is a certain additional breadth of its face on the steam side, more than sufficient to cover the aperture in the cylinder when the valve is at half stroke; and the lead is properly what the steam aperture is open for admission of the steam, when the piston is at the top or bottom of the cylinder, about to commence the returning stroke.

Of the Beam or Side Levers of a Steam Engine.

The beam of an engine during its motion describes a curve more or less, varying with the radius of the beam and length of the stroke, the deviation from the straight line being the versed sine of the arc described by the beam; hence the determined point for the centre of the cylinder, so that the angles of the links in the parallel motion may be rendered equal, and to effect which observe the following rule:—

To the radius, or half the length of the beam, add half the length of the stroke, multiply the sum by their difference, and from the radius subtract the square root of the product, the remainder equal the versed sine in equal terms of unity.

EXAMPLE.—What is the versed sine to the arc formed by the beam of a steam engine, the radius of the arc, or half the length of the beam being $7\frac{1}{2}$ feet, and the stroke of the piston $5\frac{1}{2}$ feet.

Half the stroke equal 2.75 feet.

Then, $7.5 + 2.75 = 10.25$ and $7.5 - 2.75 = 4.75$, hence, $\sqrt{10.25 \times 4.75} = 6.9775$ and $7.5 - 6.9775 = .5225$ of a foot for the versed sine, which may be reduced to inches and parts,

Thus, .5225

× 12, because 12 inches = 1 foot.

6.27

× 8, because 8 parts = 1 inch.

2.16, or $6\frac{1}{8}$ inches nearly.

NOTE.—The length of the beam is generally made three times the length of the stroke.

NS.

FIG. 3rd. A motion that is chiefly used in marine Engines.

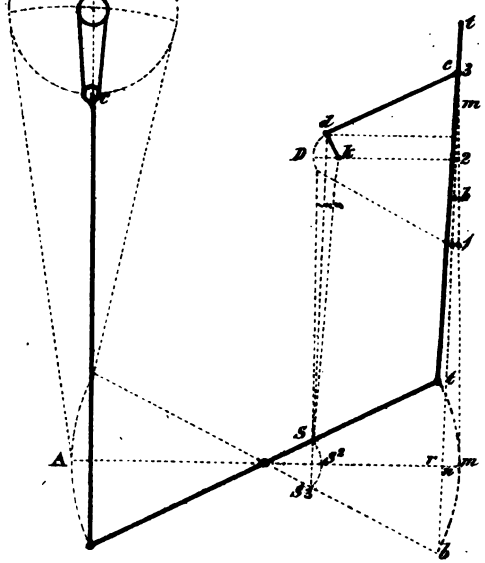


Table of versed Sines to Beams and Strokes of various lengths.

Radius, or half the length of beam in feet.		Stroke in ft. & in.	Versed Sine in inches.	Radius, or half the length of beam in feet.		Stroke in ft. & in.	Versed Sine in inches.	Radius, or half the length of beam in feet.		Stroke in ft. & in.	Versed Sine in inches.
3 feet.		1 6	1 1/2	6 feet.		3 6	3	9 feet.		5 0	4 1/2
		1 9	1 3/4			4 0	4			5 6	5 1/2
		2 0	2			4 6	5			6 0	6
		2 3	2 5/8			5 0	6 1/2			6 6	7 1/2
3 1/2 feet.		2 0	1 3/4	6 1/2 feet.		3 6	2 7/8	9 1/2 feet.		5 0	4
		2 3	2 1/4			4 0	3 3/4			5 6	4 3/4
		2 6	2 3/4			4 6	4 3/4			6 0	5 1/2
		2 9	3 1/4			5 0	5 3/4			6 6	6 1/2
4 feet.		2 3	2	7 feet.		4 0	3 1/4	10 feet.		5 6	4 1/2
		2 6	2 1/2			4 6	4 1/4			6 0	5 1/4
		2 9	3			5 0	5 1/4			6 6	6 1/4
		3 0	3 1/2			5 6	6 1/2			7 0	7 1/2
4 1/2 feet.		2 6	2 1/4	7 1/2 feet.		4 0	3 1/2	10 1/2 feet.		5 6	4 1/2
		2 9	2 3/4			4 6	4 1/4			6 0	5 1/4
		3 0	3			5 0	5 1/4			6 6	6 1/4
		3 6	4 1/4			5 6	6 3/4			7 0	7 1/2
5 feet.		2 9	2 1/2	8 feet.		4 6	3 3/4	11 feet.		6 0	5
		3 0	2 3/4			5 0	4 1/4			6 6	5 1/2
		3 6	3 1/2			5 6	5 1/4			7 0	6 1/4
		3 9	4 1/4			6 0	6 1/4			7 6	7 1/4
5 1/2 feet.		3 0	2 1/4	8 1/2 feet.		4 6	3 3/4	12 feet.		6 6	5 1/2
		3 6	3 1/4			5 0	4 1/2			7 0	6 1/4
		4 0	4 1/4			5 6	5 1/2			7 6	7 1/4
		4 6	5 1/4			6 0	6 1/2			8 0	8 1/4

OF THE PARALLEL MOTION.

The parallel motion in a steam engine is the means employed for the guidance of the piston and rod in a truly rectilenial path, when the effective power of the steam is to be transmitted through the medium of a beam or levers moving upon an axis; hence, various modifications are inevitably required, *(see Table of Parallel Motions,)* but whatever may be the form demanded by the situation, the principle remains the same, and its accuracy entirely depends upon the *radius rods* being of a proper length, for which the following approximate rule will be found sufficiently correct.

RULE.—From the radius of the beam or lever, sub-

tract the length of parallel bar, divide the square of the remainder by the length of the parallel bar, and the quotient is the length of radius rods in equal terms of unity.

EXAMPLE.—Suppose the radius or half length of a beam equal 84 inches, and the length of parallel bar 48 inches, required the length of radius rods,

$84-48=36$ and $\frac{36^2}{48}=27$ inches, length of radius rods.

A Table containing the lengths of Radius Rods for Motions, with Beams and Parallel Bars of various lengths.

Radius of beams in feet.	Parallel bars in feet.	Radius rods in feet and inches.
4 feet.	2	2 0
	2 1/4	1 4 3/4
	2 1/2	0 10 1/2
	2 3/4	0 6
4 1/2 feet.	2	3 1 1/2
	2 1/4	2 3
	2 1/2	1 7 1/2
	2 3/4	1 1 1/2
	3	0
5 feet.	2 1/4	3 4 3/4
	2 1/2	2 6
	2 3/4	1 10 1/2
	3	1 4
	3 1/4	0 11 1/2
	3 1/2	0 7 1/2
5 1/2 feet.	2 1/4	4 8 3/4
	2 1/2	3 7 1/2
	2 3/4	2 9
	3	2 1
	3 1/4	1 6 1/2
	3 1/2	1 1 1/2
	3 3/4	0 9 1/2
6 feet.	2 1/4	5 10
	2 1/2	5 0
	2 3/4	4 3 1/2
	3	3 9
	3 1/4	3 1 1/2
	3 1/2	2 7
	3 3/4	2 1 1/2
	4	1 9
	4 1/4	1 4 1/2
	4 1/2	1 0
	4 3/4	0 8 1/2

Radius of beams in feet.	Parallel bars in feet.	Radius rods in feet and inches.
6 1/2 feet.	3	4 1 1/2
	3 1/4	3 8
	3 1/2	3 2 1/2
	3 3/4	2 8
	4	2 2 1/2
	4 1/4	1 9
	4 1/2	1 3 1/2
	4 3/4	0 10
7 feet.	3 1/4	4 4
	3 1/2	3 8
	3 3/4	3 2 1/2
	4	2 8
	4 1/4	2 2 1/2
	4 1/2	1 9
	4 3/4	1 3 1/2
	5	0 10
7 1/2 feet.	3 1/4	4 6 3/4
	3 1/2	3 9
	3 3/4	3 3 1/2
	4	2 6
	4 1/4	2 0
	4 1/2	1 7
	4 3/4	1 1
	5	0 11 1/2
	5 1/4	
8 feet.	3 1/4	5 9 1/2
	3 1/2	4 9 1/2
	4	4 0
	4 1/4	3 8
	4 1/2	3 2
	4 3/4	2 8
	5	2 2
	5 1/4	1 9
	5 1/2	1 3 1/2

Radius of beams in feet.	Parallel bars in feet.	Radius rods in feet and inches.
8 1/2 feet.	4	5 6 1/4
	4 1/4	4 3
	4 1/2	3 6 1/2
	4 3/4	2 11 1/2
	5	2 5
	5 1/4	2 0 1/2
	5 1/2	1 7 1/2
9 feet.	4 1/4	5 8 1/2
	4 1/2	4 6
	4 3/4	3 9 1/2
	5	3 2 1/2
	5 1/4	2 8
	5 1/2	2 2 1/2
	5 3/4	1 10
9 1/2 feet.	4 1/4	5 6 1/2
	4 1/2	4 3
	4 3/4	3 6
	5	2 10
	5 1/4	2 5
	5 1/2	2 0
	5 3/4	1 6
	6	1 1
10 feet.	4 3/4	5 9 1/2
	5	5 0
	5 1/4	4 8 1/2
	5 1/2	3 8
	5 3/4	3 1 1/2
	6	2 8
	6 1/4	2 3
	6 1/2	1 10 1/2

Radius of beams in feet.	Parallel bars in feet.	Radius rods in feet and inches.
10 1/2 feet.	5	6 0 1/2
	5 1/4	5 3
	5 1/2	4 5 1/2
	5 3/4	3 11
	6	3 3 1/2
	6 1/4	2 10 1/2
	6 1/2	2 5 1/2
11 feet.	5 1/4	6 3 1/2
	5 1/2	5 6
	5 3/4	4 9 1/2
	6	4 2
	6 1/4	3 7 1/2
	6 1/2	3 1 1/2
11 1/2 feet.	5 1/2	6 6 1/2
	5 3/4	5 9
	6	5 0 1/2
	6 1/4	4 5
	6 1/2	3 10 1/2
	6 3/4	3 4
	7	2 10 1/2
	7 1/4	2 6
12 feet.	5 3/4	6 8 1/2
	6	6 0
	6 1/4	5 3 1/2
	6 1/2	4 7 1/2
	6 3/4	4 1
	7	3 6 1/2
	7 1/4	3 1
	7 1/2	2 8 1/2

To obtain the proper lengths of Connecting Rods, Side Rods, &c.

1. The proper length for the connecting rod of a beam engine is the perpendicular distance between the centre of beam and centre of fly wheel shaft.

2. The proper lengths for the side rods of a lever engine is the perpendicular distance between centre of lever, and centre of piston crosshead at half stroke.

3. The proper lengths for connecting rods of direct action engines, is the distance between the centre of crank axle, and centre of piston crosshead at half stroke.

4. The proper length for an eccentric rod is the distance between the centre of fly wheel shaft, or centre of revolution, and centre of stud in traverse shaft, when the valve is at half stroke.

OF THE FLY WHEEL.

The fly wheel is a heavy circular ring, generally of cast iron, and for the purpose of equalizing the motion of the engine, by absorbing the surplus force at one part of the action to distribute it again when the action is deficient. Its diameter is from 3 to $3\frac{1}{2}$ times the length of the stroke, and for safety should not exceed, in the velocity of its rim, 12 feet per second.

Numerous rules exist amongst engineers by which to determine the proper weight for the rim of a wheel of given diameter and velocity, some of less and others of more complexity in their mode of calculation; but the following I have selected for its simplicity, and probably equal efficiency to any of those professedly of more minute investigation.

RULE.—Divide 1400 times the number of horses' power the engine is equal to, by the diameter of the wheel in feet, multiplied by the number of revolutions per minute, and the quotient is the weight of the ring or rim of the wheel in cwts.

EXAMPLE.—Required the weight proper for the rim of the fly wheel to an engine of 30 horses' power, the diameter to be 25 feet, and to make 18 revolutions per minute:

$$\frac{1400 \times 30}{25 \times 18} = \frac{42000}{450} = 93.3 \text{ cwts.}$$

The following rule from Tredgold is comparatively simple, and may be used without taking the power of the engine into account.

RULE.—Multiply 40 times the pressure on the piston in lbs. by the radius of the crank in feet,—divide the product by the cube of the radius of the wheel in feet, multiplied by its revolutions per minute, and the quotient is the sectional area of the rim in inches.

EXAMPLE.—Suppose a cylinder of 30 inches diameter, steam at 18 lbs. per square inch, radius of crank 3 feet, diameter of wheel 25 feet, velocity 18 revolutions per minute: required the sectional area of the rim.

Area of piston = 706 inches.

$$\frac{706 \times 18 \times 40 \times 3}{12.5^3 \times 18} = \frac{1524960}{35154} = 43 \text{ inches,}$$

the cross sectional area.

To determine the dimensions of the ring, suitable to a given weight in cast iron.

RULE 1.—Make the breadth in inches about equal to the square root of the weight in cwts.

2.—Add together the inside and outside diameters of the ring in inches, multiply the sum by their difference, and by .2065 for a devisor, by which divide the required weight in lbs., and the quotient is the thickness of the ring in inches. Thus,—Suppose the weight and diameter of the wheel as above; required the breadth and thickness.

$\sqrt{93.3} = 9.7$ inches, breadth of ring, or say $9\frac{1}{2}$,

Then, $25 \times 12 = 300$ inches, and
$93.3 \times 112 = 10449.6$ lbs.
$300 - 19 = 281$, or inside diameter.
$300 + 281 \times 19 \times .2065 = 2279.6$,
And, $\frac{10449.6}{2279.6} = 4.5$ inches in thickness.

Or, if the ring be required of a cylindrical form, multiply the square root of the cross sectional area by 1.12837, and the product is the diameter. Hence,

$$\sqrt{9.5 \times 4.5} \times 1.12837 = 7.38 \text{ inches diameter.}$$

When a fly wheel is not of sufficient weight, and the momentum is to be obtained by increased velocity, to find the proper velocity required.

Rule.—Multiply the required momentum of the wheel by the given number of revolutions per minute, and divide the product by the weight of the wheel ring or rim given, the quotient equal the number of revolutions required for the wheel per minute.

Example.—Let the weight of a fly wheel rim equal 43.3 cwt., with a velocity of 20 revolutions per minute, required the proper velocity, so that the momentum may be increased equal to 65 cwt., by using the same wheel.

$$\frac{65 \times 20}{43.3} = 30 \text{ revolutions per minute.}$$

When an engine requires a fly wheel of a known weight at a given number of revolutions per minute, to find what weight of rim will be required when the velocity is either to be increased or diminished.

Rule.—Multiply the given weight of rim, by the given velocity per minute, divide the product by the required volocity or number of revolutions per minute, and the quotient is the weight of the rim in equal terms of unity.

EXAMPLE.—Suppose the required weight for the rim of a fly wheel be 65 cwt., at 20 revolutions per minute; but of necessity the motion is compelled to be increased to 30 revolutions per minute; required the weight, the rim of the wheel must be equal to

$$\frac{65 \times 20}{30} = 43.3 \text{ cwt. for the weight of the rim.}$$

THE GOVERNOR, OR REGULATOR,

Is a necessary appendage attached to land or stationary engines, for the purpose of regulating the quantity of steam according to the quantity of work, and thereby causing a uniformity of motion, which otherwise would not be the case.

Governors are variously constructed, to suit the different situations in which they require to be placed, but their general principle is the same, and consists of a double pendulum attached to, and made to revolve round on a spindle by the power of the engine; consequently, the pendulums ought to be of a certain length to correspond to a given velocity,—Or, the velocity made to correspond with pendulums of a given length, Hence, according to the nature of a pendulum, the square root of its length multiplied by the number of vibrations in a given time equal a number by which the length and number of vibrations of other pendulums are regulated; thus, a pendulum that will vibrate seconds, or 60 in the latitude of London, is 39.1393 inches long; and $\sqrt{39.1393} \times 60 = 375.36$, or, for the purposes of a governor, 375; and hence,

RULE 1.—Divide 375 by the square root of the pendulum's length, and the quotient equal the vibrations per minute, Or half the quotient equal the number of revolutions in the same time.

2.—Divide 375 by twice the number of revolutions

per minute, and the square of the quotient equal the pendulum's length in inches.

EXAMPLE 1.—Required the number of revolutions per minute for a governor with pendulums 30 inches in length.

$$\frac{375}{\sqrt{30}} = 68.5 \div 2 = 34.25 \text{ revolutions per minute.}$$

EX. 2.—Required the length of pendulums for a governor to make 47 revolutions per minute.

$$\frac{375}{47 \times 2} = 3.99^2 = 15.92 \text{ inches in length.}$$

The motion of a governor is generally derived from the fly wheel shaft of an engine, and communicated by means of pulleys, wheels, &c.; therefore, *to find the diameter of a pulley, or number of teeth in a wheel to produce any required velocity*, observe the following

RULE.—Multiply the diameter of the pulley, or number of teeth in the wheel on the governor spindle, by the velocity of the governor, or number of revolutions per minute, and divide by the velocity or number of revolutions of the engine in the same time; the quotient is the pulley's diameter, or number of teeth in the wheel on the fly wheel shaft. Or, multiply the velocity of the engine per minute by the diameter of the pulley, or number of teeth in the wheel on the fly wheel shaft, and divide by the required velocity of the governor; the quotient is the pulley's diameter or number of teeth in the wheel on the governor spindle.

EXAMPLE.—Required the diameter of a pulley for the spindle of a governor, so that it may perform 36 revolutions per minute; velocity of the engine 22, and the pulley on the fly wheel shaft 18 inches diameter.

$$\frac{22 \times 18}{36} = 11 \text{ inches diameter.}$$

Ex. 2.—Suppose an engine and governor situated as follow :—

Velocity of the engine 34 revolutions per minute,
Velocity of the governor 52 revolutions per minute,
Diameter of pulley on fly wheel shaft 16 inches,
Diameter of pulley on intermediate shaft 12 inches,
Wheel on governor spindle 40 teeth ;

Required the number of teeth in the wheel on the intermediate shaft.

$$\frac{52 \times 40 \times 12}{34 \times 16} = 46 \text{ teeth.}$$

Ex. 3.—Again, suppose the engine and governor situated as above ; required the diameter of the pulley on the intermediate spindle.

$$\frac{34 \times 16 \times 46}{52 \times 40} = 12 \text{ inches diameter.}$$

Note.—The weight of the balls in lbs. ought to be about 1¼ times the length of the pendulums in inches, and the levers to the throttle valve ought to be so adjusted that the greatest angle of the pendulums with the spindle may not exceed 45 degrees.

On the proper Management of a Steam Engine.

In the duties of an engineer, one of the most important is that of properly qualified attention to the boiler, it being not only that portion of the structure from which the most dangerous consequences may arise, but it is that, also, in which the vital principle of the engine is generated and supported :—

Every individual, before being considered duly qualified to undertake the care of a steam engine, ought to be perfectly intimate with the following necessitous points connected therewith.

1.—That it is of the most essential consequence to see that every accessible portion of the boiler is kept thoroughly clean, as on this, in a great measure,

depends its entire preservation and beneficial results to the economic production of steam.

2.—That the flues or tubes be also kept clean and all tight; as a trifling leak soon destroys the boiler by oxidation, and accumulated soot prevents the generation of steam, by the prevention of heat to the water.

3.—That the mud and man-hole doors are properly situated and securely screwed up; as many accidents have occurred through apparent inattention to this important point; in some instances the cross bars have not been properly situated, in other instances the threads of the screws have been rendered imperfect by oxidation, and not renewed. But let it be one undeviating maxim, that when steam is up, if a mud-hole door leak, never attempt to screw it up, but rather wait until the boiler is empty, then see that the joint is made properly.

4.—That all cocks, or tubes, by which the quantity of water in the boiler is indicated, be free of mud or accumulation of scale, so as not, in the slightest degree, to intercept a free passage to the water.

5.—That the boiler be filled to a proper height with water, as pure as possible, that is, free from saline substances or earthy matters, both of which are exceedingly detrimental to a boiler.

6.—That the float, (if any) by which to govern the quantity of feed water admitted into the boiler, be entirely free to rise or fall by its own gravity, with any fluctuation of the water.

7.—That the safety valve is properly adjusted, and instantly buoyant, when the pressure of steam arrives at the calculated force indicated by the steam gauge.

8.—That the fire bars are kept constantly covered with the fuel, at as near as possible a uniform thickness, and the steam maintained at a proper height, observing to open the fire doors as seldom as possible.

These observations being applicable to the welfare of all boilers whatever; but further, in respect to marine boilers, where sea water is used, great attention is required on the part of the engineer on watch, to see that the feed is so set that it may, from the lowest point of water carried therein, accumulate so as to reach the top of the gauge glass twice every watch, or once every two hours, and as regularly blown out to where it began to accumulate; if this be not properly attended to, the water may become super-saturated, and a deposit of salt formed upon the plates, in which the caloric will be retained, causing them, by its detention, to become red hot; ultimately, and not without danger, the boiler may be destroyed.

In some vessels boilers are supplied with what are termed *brine pumps*, they being for the purpose of withdrawing from the boilers all water impregnated with salts, to a certain extent; but, it being found in practice that reliance cannot always be placed in them, it is prudent, and more satisfactory, to use occasionally an hydrometer, to test by the gravity of the water their qualified action.

Saturated water contains about $\frac{1}{3}\frac{2}{3}$ parts of salt, but reckoning the saltness of sea water 1. that which is in the boiler should never, if possible, exceed 4. or $\frac{4}{3}$ parts of salt.

Engineers ought also to be familiar with what steps to pursue in the case of boilers priming or fermenting, this being found frequently to take place, especially in those that are short of steam room, and, occasionally, in changing from fresh to salt water, or from salt to fresh, particularly if the water is muddy; such cases require generally a partial closing of the throttle valves, also a diminution of the supply of injection, and opening of the furnace doors. But if the priming continue to defy all such means resorted to, as in some instances

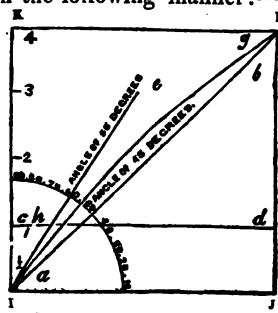
I have witnessed, then, of necessity, damp the fires with water, taking due precaution not to stand opposite the doors, whereby to catch the effects of scalding, by the rush of steam unavoidably formed in the furnace. Drawing the fires is a more preferable determination, if time can be obtained, but sometimes the diminution of water in the gauge glass is so rapid, that delay, to effect such a purpose, is unsafe. If, by neglect or otherwise, the plates of the furnaces should become red hot, through deficiency of water in the boiler, water should not, by any means, be thrown upon them whilst in that state, neither ought the safety valve to be opened, as pernicious consequences would, in all probability, be the ultimate result.

The engine of itself requires little of intricate attention, but it is necessary that every engineer should be possessed of a properly qualified knowledge of the nature and actual utility of the various parts of which the machine is composed, and also of a ready conceptive mind, formed by studious investigation and a jealous watchfulness to probable consequences likely to arise through any sudden derangement, which sometimes unavoidably takes place, and most frequently where the means of renewal or that of obtaining a proper repair is quite inaccessible. Proper attention to all the bearings is particularly necessary, so as to guard against their becoming hot, and causing to them ultimate destruction by tearing or cutting of their surfaces. Attention to all the packings is also particularly necessary, and to see that no portion of air whatever be admitted, so as to destroy the effects of the vacuum in any degree; and the temperature of the condenser, or the condensed water, ought never, if possible, to exceed 100° Fahrenheit. These remarks, and a due care to lubrication, are the chief demands that the engine requires in all ordinary cases of working.

OF THE SCREW, AS A PROPELLER.

The screw, as a mode of propelling steam vessels, is now assuming so much importance that it requires a brief notice, although the conflicting results which have been obtained by different engineers precludes the possibility at present of giving any well-ascertained proportions. This propeller is generally placed in the dead wood of the vessel, just before the rudder, and the shaft is parallel to the keel.

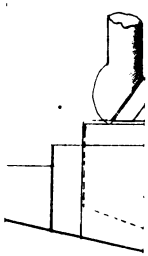
The most approved screws are of two kinds: that having a uniform pitch or angle, and that which has a varying angle, invented by Mr. Woodcroft. The first is set off by describing a line round a cylinder at a uniform angle to the axis. In the second, the angle is continually increasing, and is set off by Mr. Woodcroft in the following manner:—Draw a right line equal to



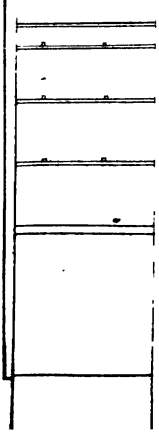
the direct length of the spiral required, as I J, and on which describe the square I J K L; draw the diagonal line I L, which line will form an angle with the line I J of 45 degrees; divide the side I K of the square into four equal parts, and through the first of which draw the line *c d* parallel to the line I J; from the angle I of the square draw the line I *e* at an angle of 55 degrees with the line I J, and where the line I *e* intersects the horizontal line *c d* at the point *h*, it gives a point through which the segment of a circle *f g* must be drawn from the angle I to the angle L of the square I J K L. If then the paper or other medium upon which this segment of a circle *f g* is drawn be transferred to or rolled upon a cylinder,

GINES

R,



SEL,



then will the line $f g$ point out upon the cylinder the outer circumference of the spiral worm required.

To determine the proper pitch for a screw propellor, the velocity of the screw, the speed of the vessel, and assumed slip of the screw being given.

RULE.—Divide the velocity of the vessel, plus the assumed slip in feet per minute by the number of revolutions the screw is intended to make in the same time, the quotient will be the pitch of the screw in feet.

EXAMPLE.—Suppose the intended speed of a vessel to be 10 miles per hour, the expected slip 2 miles, and the revolutions of the screw 120 per minute.

10 miles per hour = 860 feet per minute, and
2 „ „ „ = 172 „ „ „ then
120 : 860 + 172 :: 1 : 8.6 feet, the pitch required.

To determine the amount of loss by slip, the speed of the vessel, the revolutions of the screw per minute, and the pitch of the screw being given.

RULE.—Multiply the pitch of the screw by the number of revolutions per minute, and from the product subtract 88 times the speed of the vessel in English miles per hour, and the remainder will be the loss by slip in feet per minute.

EXAMPLE.—Suppose the ascertained speed of a vessel propelled by a screw of 8.8 feet pitch is found to be 10 English miles per hour, how much is lost by slip, the screw making 120 revolutions per minute:—

$10 \times 88 = 880$ and $120 \times 8.8 = 1056$; Then, $1056 - 880 = 176$ feet per minute, or 2 miles per hour.

To ascertain the amount of helical surface in one convolution of a screw.

RULE.—Multiply the radii of the screw by the radii minus the radii of its shaft, or centre, the product is the

difference of their squares; then multiply the difference of their squares by the constant number 3.1416, and that product by the secant of the angle of the screw, the result is the area of the helical surface in square feet.

EXAMPLE.—Suppose the radii of a screw equal 8 feet, the diameter of its centre 2 feet, and the angle of inclination 27 degrees, required the helical surface.

$8 \times 7 = 56 \times 3.1416 \times 1.1223 = 197.4458$ square feet.

The distance which a screw traverses while working in a solid, and making one revolution, is called the *pitch;* and the difference between the pitch, and the actual distance which a vessel would proceed while the screw made one revolution, is called the *slip*.

The usual method of working the screw, is to place the ordinary marine engine in the centre of the vessel, and connect it, by spur wheels, to a horizontal shaft to which the screw is attached. This shaft is made to revolve much faster than the engines, to give a great velocity to the screw.

Mr. Grantham, of this town, has, however, adopted a plan by which the spur wheels are removed, and the engines applied direct to the screw shaft. This system offers so many advantages, and has been attended with so much success, that we have given a plate to show the mode of applying it.

Table of Approximate Rules for practical purposes.

Diameter of a circle × 3.1416 = the circumference.
Circumference „ × .31831 = the diameter.
Diameter „ × .8862 = the side of an equal square.
Diameter „ × .7071 = the side inscribed square.
Side of a square × 1.128 = the diameter of an equal circle.
Square of diameter × .7854 = the area of the circle.
Square root of area × 1.12837 = the diam. of equal circle.
Square of the diam. of a sphere × 3.1416 = convex surface.
Cube of the diameter of a sphere × .5236 = the solidity.
Diameter of a sphere × .806 = dimensions of equal cube.
Diameter of a sphere × .6667 = length of equal cylinder.
Square inches × .00695 = square feet.
Cubic inches × .00058 = cubic feet.
Cubic feet × .03704 = cubic yards.
Circular inches × .00456 = square feet.
Cylindrical inches × .0004546 = cubic yards.
Cylindrical feet × .02909 = cubic yards.
Lineal feet × .00019 = English miles.
Lineal yards × .000568 = English miles.
Square yards × .0002067 = English acres.
Avoirdupois lbs. × .009 = cwts.
Avoirdupois lbs. × .00045 = tons.
Cubic feet × 6.232 = imperial gallons.
Cubic inches × .003607 = imperial gallons.
French metres × 3.281 = English feet.
——— litres × .2202 = imperial gallons.
——— grammes × .002205 = avoirdupois lbs.
——— kilogrammes × 2.205 = avoirdupois lbs.
183.346 circular inches = 1 square foot.
2200 cylindrical inches = 1 cubic foot.

Table of Natural Sines, Co-sines, Tangents, Co-tangents, Secants, and Co-secants, to every degree of the Quadrant.

Deg.	Sines.	Co-sines.	Tang.	Co-tang.	Secants.	Co-sec.	Deg.
0	.00000	1 00000	00000	Infinite	1.00000	Infinite.	90
1	.01745	.99985	01746	57.2900	1.00015	57.2987	89
2	.03490	.99939	03492	28.6363	1.00061	28.6537	88
3	.05234	.99863	.05241	19.0811	1.00137	19.1073	87
4	06976	.99756	06993	14.3007	1.00244	14.3356	86
5	08716	.99619	.08749	11.4301	1.00382	11.4737	85
6	.10453	.99452	.10510	9.51236	1.00551	9.56677	84
7	.12187	.99255	12278	8.14435	1.00751	8.20551	83
8	.13917	.99027	.14054	7.11537	1.00983	7.18530	82
9	.15643	.98769	.15838	6.31375	1.01246	6.39245	81
10	.17365	.98481	.17633	5.67128	1.01543	5.75877	80
11	.19081	.98163	.19438	5.14455	1.01872	5.24084	79
12	.20791	.97815	.21256	4.70463	1.02234	4.80973	78
13	.22495	.97437	.23087	4.33148	1.02630	4.44541	77
14	24192	.97030	24933	4.01078	1.03061	4.13356	76
15	.25882	.96593	26795	3.73205	1.03528	3.86370	75
16	27564	.96126	.28675	3.48741	1.04030	3.62796	74
17	.29237	.95630	30573	3.27085	1.04569	3.42030	73
18	.30902	95106	.32492	3.07768	1.05146	3.23607	72
19	.32557	.94552	34433	2.90421	1.05762	3.07155	71
20	.34202	.93969	.36397	2.74748	1.06418	2.92380	70
21	.35837	.93358	.38386	2.60509	1.07114	2.79043	69
22	37461	.92718	.40403	2.47509	1.07853	2.66947	68
23	.39073	.92050	.42447	2.35585	1.08636	2.55930	67
24	.40674	.91355	.44523	2.24604	1.09464	2.45859	66
25	.42262	.90631	.46631	2.14451	1.10338	2.36620	65
26	.43837	.89879	.48773	2.05030	1.11260	2.28117	64
27	.45399	.89101	.50952	1.96261	1.12233	2.20869	63
28	.46947	.88295	53171	1.88073	1.13257	2.13005	62
29	.48481	.87462	.55431	1.80405	1.14335	2.06266	61
30	50000	.86603	57735	1.73205	1.15470	2.00000	60
31	.51504	.85717	60086	1.66428	1.16663	1.94160	59
32	.52992	.84805	.62487	1.60033	1.17918	1.88708	58
33	54464	.83867	.64941	1.53986	1.19236	1.83608	57
34	.55919	.82904	.67451	1.48256	1.20622	1.78829	56
35	.57358	.81915	.70021	1.42815	1.22077	1.74345	55
36	58778	.80902	.72654	1.37638	1.23607	1.70130	54
37	.60181	.79863	.75355	1.32704	1.25214	1.66164	53
38	.61566	.78801	.78129	1.27994	1.26902	1.62427	52
39	.62932	.77715	.80978	1.23490	1.28676	1.58902	51
40	.64279	.76604	.83910	1.19175	1.30541	1.55572	50
41	.65606	.75471	.86929	1.15037	1.32511	1.52425	49
42	.66913	.74314	.90040	1.11061	1.34561	1.49448	48
43	68200	.73135	.93251	1.07237	1.36766	1.46628	47
44	.69466	.71934	.96569	1.03553	1.39012	1.43956	46
45	.70711	.70711	1.00000	1.00000	1.41421	1.41421	45
Deg.	Co-sine.	Sines.	Co-tang.	Tang.	Co-sec.	Secants.	Deg.

Table containing the weight of Square Bar Iron, from 1 *to* 10 *feet in length, and from* $\frac{1}{4}$ *of an inch to* 6 *inches square.*

Inches square.	LENGTH OF THE BARS IN FEET.									
	1 foot.	2 feet.	3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.	9 feet.	10 feet.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
$\frac{1}{4}$	0.2	0.4	0.6	0.8	1.1	1.3	1.5	1.7	1.9	2.1
$\frac{5}{16}$	0.5	1.0	1.4	1.9	2.4	2.9	3.3	3.8	4.3	4.8
$\frac{3}{8}$	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.5
$\frac{7}{16}$	1.3	2.6	4.0	5.3	6.6	7.9	9.2	10.6	11.9	13.2
$\frac{1}{2}$	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0
$\frac{9}{16}$	2.6	5.2	7.8	10.4	12.9	15.5	18.1	20.7	23.3	25.9
1 in.	3.4	6.8	10.1	13.5	16.9	20.3	23.7	27.0	30.4	33.8
$1\frac{1}{16}$	4.3	8.6	12.8	17.1	21.4	25.7	29.9	34.2	38.5	42.8
$1\frac{1}{8}$	5.3	10.6	15.8	21.1	26.4	31.7	37.0	42.2	47 5	52.8
$1\frac{3}{16}$	6.4	12.8	19.2	25.6	32.0	38.3	44.7	51.1	57.5	63.9
$1\frac{1}{4}$	7.6	15.2	22.8	30.4	38.0	45.6	53.2	60.8	68 4	76.0
$1\frac{5}{16}$	8.9	17.9	26.8	35.7	44.6	53.6	62.5	71.4	80.3	89.3
$1\frac{3}{8}$	10.4	20.7	31.1	41.4	51.8	62.1	72.5	82.8	93.2	103.5
$1\frac{7}{16}$	11.9	23.8	35.6	47.5	59.4	71.3	83.2	95.1	106.9	118.8
2 in.	13.5	27.0	40.6	54.1	67.6	81.1	94.6	108 2	121.7	135.2
$2\frac{1}{16}$	15.3	30.5	45.8	61.1	76.3	91.6	106.8	122.1	137.4	152.6
$2\frac{1}{8}$	17.1	34.2	51.3	68.4	85.6	102.7	119.8	136.9	154.0	171.1
$2\frac{3}{16}$	19.1	38.1	57.2	76.3	95.3	114.4	133.5	152.5	171.6	190.7
$2\frac{1}{4}$	21.1	42.2	63.4	84.5	105.6	126.7	147.8	169.0	190.1	211.2
$2\frac{5}{16}$	23.3	46.6	69.9	93.2	116.5	139.8	163.0	186.3	209.6	232 9
$2\frac{3}{8}$	25.6	51.1	76.7	102.2	127.8	153.4	178.9	204.5	230.0	255.6
$2\frac{7}{16}$	27.9	55.9	83.8	111.8	139.7	167.6	195.7	223.5	251.5	279.4
3 in.	30.4	60.8	91.2	121.7	152.1	182.5	212.9	243.3	273.7	304.2
$3\frac{1}{16}$	33.0	66.0	99.0	132.0	165.1	198.1	231.1	264.1	297.1	330.1
$3\frac{1}{8}$	35.7	71.4	107.1	142.8	178.5	214.2	249.9	285.6	321.3	357.0
$3\frac{3}{16}$	38.5	77.0	115.5	154 0	192.5	231.0	269 5	308.0	346.5	385.0
$3\frac{1}{4}$	41.4	82.8	124.2	165.6	207.0	248.4	289.8	331.3	372.7	414.1
$3\frac{5}{16}$	44.4	88.8	133.3	177.7	222.1	266.5	310.9	355.3	399.8	444.2
$3\frac{3}{8}$	47.5	95.1	142 6	190.1	237.7	285.2	332.7	380.3	427.8	475.3
$3\frac{7}{16}$	50.8	101.5	152.3	203.0	253.8	304.5	355.3	406.0	456.8	507.6
4 in.	54.1	108.2	162.3	216.3	270.4	324.5	378.6	432.7	486.8	540.8
$4\frac{1}{16}$	57.5	115.0	172.6	230.1	287.6	345.1	402.6	460.1	517.7	575.2
$4\frac{1}{8}$	61.1	122.1	183.2	244.2	305.3	366.3	427.4	488.4	549.5	610.6
$4\frac{3}{16}$	64 7	129.4	194.1	258.8	323.5	388 2	452.9	517.6	582.3	647.0
$4\frac{1}{4}$	68.4	136.9	205.3	273.8	342.2	410.7	479.1	547.6	616.0	684.5
$4\frac{5}{16}$	72.3	144.6	216.9	289.2	361.5	433.8	506.1	578.4	650.7	723.1
$4\frac{3}{8}$	76.3	152.5	228.8	305.1	381 3	457.6	533.8	610 1	686.4	762.6
$4\frac{7}{16}$	80.3	160.7	241.0	321.3	401.7	482.0	562.3	642.7	723.0	803.3
5 in.	84.5	169.0	253.4	337.9	422.4	506.9	591.4	675.8	760.3	844.8
$5\frac{1}{16}$	93.2	186.3	279.5	372.7	465.8	559.0	652.2	745.3	838.5	931.7
$5\frac{1}{8}$	102.2	204.5	306.7	409.0	511 2	613.4	715.7	817.9	920.2	1022.4
$5\frac{3}{16}$	111.8	223.5	335.3	447.0	558.8	670.5	782.3	894.0	1005.8	1117.6
6 in.	121.7	243.3	365.0	486.7	608.3	730.0	841.6	973.3	1009.5	1216.6

Table containing the weight of Round Bar Iron, from 1 *to* 10 *feet in length, and from* ¼ *of an inch to* 6 *inches diameter.*

Inches diam.	LENGTH OF THE BARS IN FEET.									
	1 foot.	2 feet.	3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.	9 feet.	10 feet.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
¼	0.2	0 3	0 5	0 7	0 8	1.0	1.2	1 3	1 5	1 7
⅜	0.4	0 7	1 1	1.5	1 9	2 2	2.6	3.0	3 4	3.7
½	0.7	1.3	2 0	2 7	3 3	4 0	4.6	5 3	6 0	6.6
⅝	1.0	2 1	3 1	4 2	5 2	6 3	7.3	8 3	9 4	10.4
¾	1.5	3 0	4 5	6.0	7 5	9 0	10 5	11.9	13.4	14.9
⅞	2.0	4 1	6 1	8 1	10 2	12.2	14.2	16.3	18 3	20.3
1 *in.*	2.7	5 3	8 0	10 6	13 3	15.9	18.6	21.2	23.9	26.5
1⅛	3.4	6 7	10 1	13 4	16 8	20 2	23.5	26.9	30.2	33.6
1¼	4.2	8 3	12 5	16 7	2 9	25.0	29 2	33.4	37 5	41.7
1⅜	5.0	10.0	15 1	20.1	25.1	30.1	35.1	40 2	45 2	50 2
1½	6.0	11.9	17 9	23.9	29.9	35 8	41.8	47.8	53 7	59.7
1⅝	7.0	14 0	21.0	28.0	35.1	42 1	49 1	56.1	63.1	70.1
1¾	8.1	16.3	24 4	32.5	40 6	48.8	56.9	65 0	73.2	81.3
1⅞	9.3	18 7	28.0	37 3	46 7	56.0	65 3	74 7	84 0	93.3
2 *in.*	10.6	21 2	31 8	42.5	53 1	63 7	74 3	84 9	95 5	106.2
2⅛	12.0	24 0	36 0	48.0	59 9	71 9	83 9	95 9	107.9	119 9
2¼	13.4	26 9	40 3	53.8	67 2	80 6	94 1	107.5	121 0	134 4
2⅜	15.0	30 0	44 9	60.0	74 9	89.9	104.8	119.8	134 8	149.8
2½	16.7	33 4	50 1	66.8	83 4	100.1	116.8	133 5	150.2	166 9
2⅝	18.3	36 6	54 9	73 2	91 5	109.8	128.1	146.3	164 6	182.9
2¾	20.1	40 2	60 2	80.3	100 4	120 5	140 5	160.6	180.7	200.8
2⅞	21.9	43.9	65 8	87.8	109 7	131 7	153.6	175 6	197.5	219.4
3 *in.*	23.9	47 8	71 7	95.6	119.4	143 3	167 2	191.1	215.0	238 9
3⅛	25.9	51.9	77.8	103.7	129 6	155.6	81.5	207 4	233.3	259.3
3¼	28.0	56 1	84 1	112.2	140 2	168.2	196.3	224 3	253 4	280.4
3⅜	30.2	60 5	90 7	121.0	151.2	181.4	211.7	241.9	272.2	302.4
3½	32.5	65 0	97 5	130.0	162.6	195 1	227.6	260.1	292.6	325.1
3⅝	34.9	69 8	104 7	139.5	174 4	209.3	244 2	279.1	314.0	348.9
3¾	37.3	74 7	112 0	149.3	186.7	224.0	261.3	298 7	336 0	373.3
3⅞	39.9	79 7	119 6	159.5	199 3	239.2	279.0	318.9	358 8	398.6
4 *in.*	42.5	84 9	127 4	169.9	212 3	254.8	297.2	339 7	382 2	424.6
4⅛	45.2	90 3	135 5	180.7	225 9	271.0	316.2	361.4	406 6	451.7
4¼	48.0	95 9	143 9	191.8	239 8	287.7	335 7	383 6	431.6	479.5
4⅜	50.8	101 6	152 4	203 3	254.1	304.9	355 7	406.5	457.3	508.2
4½	53.8	107 5	161 3	215.0	268.8	322 6	376.3	430.1	483 8	537.6
4⅝	56 8	113 6	170 4	227.2	283 9	340.7	397 5	454.3	511.1	567 9
4¾	60.0	119 8	179 7	239 6	299 5	359 4	419 3	479.2	539.1	599.0
4⅞	63.1	126 2	189 3	252.4	315.5	378.6	441.7	504.8	567 8	630.9
5 *in.*	66.8	133 5	200 3	267.0	333.8	400.5	467.3	534.0	600.8	667.5
5⅛	73.2	146.3	219 5	292.7	365 9	439.0	512.2	585.4	658.5	731.7
5¼	80 3	160 6	240 9	321.2	401.5	481.8	562.1	642 4	722.7	803.0
5½	87 8	175 6	263.3	351.1	438.9	526 7	614.4	702 2	790.0	877.8
6 *in.*	95.6	191 1	286 7	382.2	477.8	573.3	668.9	764.4	860.0	955 5

Table containing the weight of Flat Bar Iron, 1 foot in length, of various breadths and thicknesses.

Breadth in inches.	THICKNESS IN PARTS OF AN INCH.									
	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1 Inch.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1 *in.*	0.83	1.04	1.25	1.45	1.66	1.87	2.08	2.50	2.91	3.33
1 1/4	0.93	1.17	1.40	1.64	1.87	2.00	2.34	2.81	3.28	3.75
1 1/2	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.74	4.16
1 3/4	1.14	1.43	1.71	2.00	2.29	2.57	2.86	3.43	4.01	4.58
1 7/8	1.25	1.56	1.87	2.18	2.50	2.81	3.12	3.75	4.37	5.00
1 1/4	1.35	1.69	2.03	2.36	2.70	3.04	3.38	4.06	4.73	5.41
1 1/2	1.45	1.82	2.18	2.55	2.91	3.28	3.64	4.37	5.10	5.83
1 3/4	1.56	1.95	2.34	2.73	3.12	3.51	3.90	4.68	5.46	6.25
2 *in.*	1.66	2.08	2.50	2.91	3.33	3.75	4.16	5.00	5.83	6.66
2 1/4	1.77	2.21	2.65	3.09	3.54	3.98	4.42	5.31	6.19	7.08
2 1/2	1.87	2.34	2.81	3.28	3.75	4.21	4.68	5.62	6.56	7.50
2 3/4	1.97	2.47	2.96	3.46	3.95	4.45	4.94	5.93	6.92	7.91
2 7/8	2.08	2.60	3.12	3.64	4.16	4.68	5.20	6.25	7.29	8.33
2 1/4	2.18	2.73	3.28	3.82	4.37	4.92	5.46	6.56	7.65	8.75
2 1/2	2.29	2.86	3.43	4.01	4.58	5.15	5.72	6.87	8.02	9.16
2 3/4	2.39	2.99	3.59	4.19	4.79	5.39	5.98	7.18	8.38	9.58
3 *in.*	2.50	3.12	3.75	4.37	5.00	5.62	6.25	7.50	8.75	10.00
3 1/4	2.70	3.38	4.06	4.73	5.41	6.09	6.77	8.12	9.47	10.83
3 1/2	2.91	3.64	4.37	5.10	5.83	6.56	7.29	8.75	10.20	11.66
3 3/4	3.12	3.90	4.68	5.46	6.25	7.03	7.81	9.37	10.93	12.50
4 *in.*	3.33	4.16	5.00	5.83	6.66	7.50	8.33	10.00	11.66	13.33
4 1/4	3.54	4.42	5.31	6.19	7.08	7.96	8.85	10.62	12.39	14.16
4 1/2	3.75	4.68	5.62	6.56	7.50	8.43	9.37	11.25	13.12	15.00
4 3/4	3.95	4.94	5.93	6.92	7.91	8.90	9.89	11.87	13.85	15.83
5 *in.*	4.17	5.20	6.25	7.29	8.33	9.37	10.41	12.50	14.58	16.66
5 1/4	4.37	5.46	6.56	7.65	8.75	9.84	10.93	13.12	15.31	17.50
5 1/2	4.58	5.72	6.87	8.02	9.16	10.31	11.45	13.75	16.04	18.33
5 3/4	4.79	5.98	7.18	8.38	9.58	10.78	11.97	14.37	16.77	19.16
6 *in.*	5.00	6.26	7.50	8.75	10.00	11.25	12.50	15.00	17.50	20.00

Comparative Gravity of Metals.

Bar Iron being	**1.00**	**Cast Iron being**	**1.00**	**Dry Deal being**	**1.0**
Cast Iron	= .95	**Bar Iron**	= 1.07	**Cast Iron**	= 11.0
Steel	= 1.02	**Steel**	= 1.08	**Cast Tin**	= 11.2
Copper	= 1.16	**Brass**	= 1.16	**Brass**	= 12.7
Brass	= 1.09	**Copper**	= 1.21	**Copper**	= 13.3
Lead	= 1.48	**Lead**	= 1.56	**Lead**	= 17.1

Table containing the weight of Cast Iron Balls from 3 to 12 inches diameter.

Diameter in inches.	Weight in Lbs.	Diameter in inches.	Weight in Lbs.	Diameter in inches.	Weight in Lbs.
3	3.7	6	29 7	9	100.3
3¼	4.7	6¼	33.6	9¼	108.9
3½	5.8	6⅜	37 8	9½	118.0
3¾	7.2	6½	42.3	9¾	127 6
4	8.8	7	47.2	10	137.7
4¼	10.5	7¼	52.4	10¼	148.2
4⅜	12.5	7⅜	58 0	10⅜	159.4
4½	14.7	7½	64.0	10¾	171.0
5	17.1	8	70.4	11	183 2
5¼	19.9	8¼	77.3	11½	209.4
5⅜	22 9	8⅜	84.5	12	237.9
5½	26.1	8½	92.2		

Properties of Metals.

NAMES OF METALS.	Specific gravity water being 1000.	Melting points in degrees of Fahr.	Contraction in parts of an inch per lineal foot from the fluid to the average temperature in solid state.	Cohesive strength of an inch square prism in lbs.	Scale of wire-drawing ductility.	Scale of laminable ductility.	Scale as conductors of electricity.	Ratio of power in the conduction of heat.
Platinum	19500	3280	.....	.....	3	5	...	3 8
Pure Gold	19258	2016	.....	.....	1	1	3	10.0
Mercury	13560	.....	.....	.....	...	...	...	...
Lead	11352	612	.319	1824	8	7	6	1.8
Pure Silver.....	10474	1873	.....	.....	2	2	2	9.7
Bismuth	9823	476	.156	3250	...	...	...	...
Copper, cast.....	8788	1996	.193	19072	...	...	...	...
„ wrought	8910	.....	.....	33892	5	3	1	8.9
Brass, cast	7824	1900	.210	17968	...	...	...	...
„ sheet.....	8396	.....	.....	27935	6	6	...	8.6
Iron, cast.....	7264	2786	.125	17628	...	...	...	...
„ bar	7700	.....	.137	56000	4	3	4	3.7
Steel, soft.....	7833	.....	.133	127632	...	...	...	...
„ hard	7816	.....	.....	.....	...	...	...	...
Tin, cast	7291	442	.278	4763	8	4	5	3.0
Zinc, cast.....	7190	773	.329	11334	7	8	7	3.6

NOTE.—The elastic power or direct tension of bar iron, medium quality, equal 22400 lbs. per square inch of sectional area.

Table containing the weight of Cast Iron Pipes, 1 foot in length.

Diam. of bore in inches.	THICKNESS IN INCHES.							
	⅜	½	⅝	¾	⅞	1 *in*	1⅛	1¼
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1½	6.9	9.9	.....	.....	.....	.....	.....	.....
2	8.8	12.3	16.1	20.3	.....	.....	.....	.....
2½	10.6	14.7	19.2	23.9	.....	.....	.....	.....
3	12.4	17.2	22.2	27.6	33.3	39.3	45.6	.....
3½	14.2	19.6	25.3	31.3	37.6	44.2	51.1	.....
4	16.8	22.1	28.4	35.0	41.9	49.1	56.6	64.4
4½	18.0	24.5	31.4	38.7	46.2	54.0	62.1	70.6
5	19.8	27.0	34.5	42.3	50.5	58.9	67.6	76.7
5¼	21.6	29.5	37.6	46.0	54.8	63.8	73.2	82.8
6	23.5	31.9	40.7	49.7	59.1	68.7	78.7	88.8
6½	25.3	34.4	43.7	53.4	63.4	73.4	84.2	95.1
7	27.2	36.8	46.8	56.8	67.7	78.5	89.7	101.2
7½	29.0	39.1	49.9	60.7	72.0	83.5	95.3	107.4
8	30.8	41.7	52.9	64.4	76.2	88.4	100.8	113.5
8½	32.9	44.4	56.2	68.3	80.8	93.5	106.5	119.9
9	34.5	46.6	59.1	71.8	84.8	98.2	111.8	125.8
9½	36.3	49.1	62.1	75.5	89.1	103.1	117.4	131.9
10	38.2	51.5	65.2	79.2	93.4	108.0	122.8	138.1
10½	.....	54.0	68.2	82.8	97.7	112.9	128.4	144.2
11	.....	56.4	71.3	86.5	102.0	117.8	133.9	150.3
11½	.....	58.9	74.3	90.1	106.3	122.7	139.4	156.4
12	.....	61.3	77.4	93.6	110.6	127.6	145.0	162.6
13	.....	.....	82.7	101.2	118.2	137.4	154.1	173.5
14	.....	.....	89.3	108.2	126.5	146.2	165.3	185.2
15	.....	.....	95.2	115.7	135.3	156.2	176.2	198.1
16	.....	.....	.....	123.3	143.1	166.1	187.5	211.3
17	.....	.....	.....	130.2	152.5	178.5	198.2	223.4
18	.....	.....	.....	137.0	161.2	185.3	209.1	235.6
19	.....	.....	.....	.....	169.2	195.7	222.3	247.1
20	.....	.....	.....	.....	178.1	205.2	233.2	259.0
21	.....	.....	.....	.....	.....	214.1	243.5	273.2
22	.....	.....	.....	.....	.....	223.0	254.8	285.4
23	.....	.....	.....	.....	.....	233.4	265.5	298.3
24	.....	.....	.....	.....	.....	245.2	277.5	310.6

NOTE.—The area of a circle in inches, multiplied by the length in inches, and 263 = the weight in lbs. avoirdupois of cast iron.

Table containing the weight of Solid Cylinders of Cast Iron, one foot in length, and from ¾ of an inch to 14 inches diameter.

Diameter in Inches.	Weight in Lbs.	Diameter in Inches.	Weight in Lbs.
¾	1.39	5 in.	61.96
⅞	1.88	5⅛	64.66
1 in.	2.47	5¼	68.31
1⅛	3.13	5⅜	71.00
1¼	3.87	5½	74.98
1⅜	4.68	5⅝	78.65
1½	5.57	5¾	81.95
1⅝	6.54	5⅞	85.81
1¾	7.59		
1⅞	8.71	6 in.	89.23
		6¼	96.82
2 in.	9.91	6½	104.72
2⅛	11.19	6¾	112.93
2¼	12.54		
2⅜	13.96	7 in.	121.45
2½	15.49	7¼	130.28
2⅝	17.06	7½	139.42
2¾	18.74	7¾	148.87
2⅞	20.48		158.63
		8 in.	168.15
3 in.	22.35	8¼	179.08
3⅛	24.20	8½	189.00
3¼	26.18	8¾	
3⅜	28.28		
3½	30.36	9 in.	200.77
3⅝	32.57	9¼	211.12
3¾	34.85	9½	223.70
3⅞	37.21	9¾	235.31
4 in.	39.66	10 in.	247.87
4⅛	41.80	10½	273.27
4¼	44.77		
4⅜	47.00	11 in.	299.92
4½	50.19	11½	327.81
4⅝	52.71	12 in.	356.93
4¾	55.92	13	418.90
4⅞	58.72	14	485.83

NOTE.—The area of a circle in inches, multiplied by the length in inches, and by .263 = the weight in lbs. avoirdupois of cast iron.

Table of economical advantages in using Steam expansively, by Professor Gordon, Glasgow.

Proportion of stroke made before steam is cut off	Volume after expansion, that before expansion taken as unity.	Mechanical effect developed by a given volume of steam for different degrees of expansion, temperature being supposed maintained constant.	Economy of fuel by obtaining the increase of mechanical effect thus available.	Initial pressure of steam required to allow of this degree of expansion in any given cylinder, doing the work by full pressure, with steam of this pressure taken as unity.	Initial pressure of steam required to allow of this degree of expansion in any given cylinder, doing the work by full pressure, with steam of 1.564 atmospheres, or 23 lbs., taken as unity.	Temperature corresponding to foregoing pressure or elastic force.	Weight of a cubic foot of steam of this density and pressure.	Economy of fuel indicated in this manner as resulting from the use of expansion.
			Per Cent.	Atmospheres.	Lbs.	Atmospheres.		Lbs.	Per Cent.
Total	1 00	1.0000	0	1.000	23.000	1.564	236 3	.0556	0
3– 4	1.33	1.2851	.	1.037	23.851	1.622	238.0	.0575	22½
3– 5	1.66	1.5066	33	1.105	25.415	1.713	241.8	.0604	35
4– 7	1.75	1.5596	.	1.121	25.783	1.753	242.7	.0617	36½
5– 9	1.80	1.5876	.	1.139	26.197	1.781	243.6	.0626	37½
10–19	1.90	1.6419	.	1.157	26.611	1.810	244.8	.0635	40
1– 2	2.00	1.6931	39	1.195	27.485	1.869	246.0	.0655	41
4– 9	2.25	1.8109	.	1.231	28.313	1.925	248.0	.0672	46
2– 5	2.50	1 9163	.	1.304	29.992	2.040	251.0	.0709	49
4–11	2.75	2.0116	50	1.367	31.441	2.138	254.5	.0740	51½
1– 3	3.00	2.0986	52½	1.429	32.867	2.235	257.0	.0771	53½
4–13	3 25	2.1786	.	1.491	34.293	2.332	259.3	.0802	55½
2– 7	3 50	2.2528	.	1.553	35.719	2.429	261.5	.0832	57
4–15	3.75	2.3217	.	1.589	36.547	2.485	263 5	.0849	59½
1– 4	4.00	2.3860	59	1.677	38.571	2.623	266.9	.0892	60
2– 9	4 50	2 5040	.	1.797	41.331	2.811	271.0	.0951	62
1– 5	5.00	2.609	62	1.873	43.079	2.929	273.8	.0988	64½
2–11	5 50	2.705	.	2.033	46.759	3.180	279.0	.1064	68
1– 6	6.00	2.792	65	2.149	49.427	3.361	283.0	.1118	66½
2–13	6.50	2.872	.	2.263	52.049	3.539	285.8	.1173	67½
1– 7	7.00	2 946	.	2.376	54.648	3.716	289.0	.1227	68½
1– 8	8.00	3 0794	.	2.597	59.731	4.062	294.7	.1331	70

NOTE.—Mr. M'Naught has ascertained, by the application of his indicators, that there is no economical advantage in cutting off the steam from an engine at more than three-fourths the stroke, and at two-thirds, he asserts, is the most advantageous point.

Table containing Degrees of Heat by the Fahrenheit, Reaumer, and Centigrade Thermometers, comparatively indicated.

Faht.	Reau.	Cent.	Faht.	Reau.	Cent.	Faht.	Reau.	Cent.
350	141.3	176.7	186	68.4	85.5	108	33.7	42.2
320	128.0	160 0	184	67 5	84.4	106	32.8	41.1
300	119.1	148 9	182	66.6	83.3	104	32.0	40.0
290	114.7	143.3	180	65 7	82.2	102	31.1	38.8
280	110.2	137 8	178	64.8	81.1	100	30.2	37.7
270	105.8	132 2	176	64.0	80.0	98	29.3	36.6
260	101.3	126.6	174	63.1	78.8	96	28.4	35.5
250	96.9	121.1	172	62.2	77.7	94	27.5	34.4
248	96.0	120.0	170	61.3	76.6	92	26.6	33.3
246	95.1	118 8	168	60.4	75.5	90	25.7	32.2
244	94.2	117 7	166	59 5	74 4	88	24.8	31.1
242	93.3	116.6	164	58.6	73.3	86	24.0	30.0
240	92.4	115 5	162	57.7	72.2	84	23.1	28 8
238	91.6	114 4	160	56.8	71.1	82	22.2	27.7
236	90 7	113 3	158	56.0	70 0	80	21.3	26.6
234	89 8	112.2	156	55.1	68 8	78	20.4	25.5
232	88 9	111 1	154	54.2	67 7	76	19.5	24.4
230	88.0	110 0	152	53.3	66.6	74	18.6	23.3
228	87.1	108 9	150	52.4	65.5	72	17.7	22 2
226	86.2	107 8	148	51.5	64 4	70	16.8	21.1
224	85.3	106 7	146	50 6	63 3	68	16.0	20.0
222	84.4	105 6	144	49.7	62 2	66	15.1	18.8
220	83.6	104 4	142	48 8	61.1	64	14.2	17.7
218	82.7	103.3	140	48.0	60 0	62	13.3	16.6
216	81 8	102 2	138	47.1	58 8	60	12 4	15.5
214	80 9	101.1	136	46.2	57.7	58	11.5	14.4
212	80.0	100.0	134	45.3	56.6	56	10 6	13.3
210	79.1	98 8	132	44 4	55.5	54	9.7	12.2
208	78.2	97.7	130	43.5	54.4	52	8.8	11.1
206	77.3	96 6	128	42.6	53 3	50	8 0	10.0
204	76 4	95 5	126	41.7	52 2	48	7.1	8.8
202	75 5	94 4	124	40 8	51.1	46	6.2	7.7
200	74.6	93 3	122	40 0	50 0	44	5.3	6.6
198	73.7	92.2	120	39.1	48 8	42	4.4	5.5
196	72.8	91 1	118	38.2	47.7	40	3.5	4.4
194	72.0	90.0	116	37.3	46 6	38	2.6	3.3
192	71.1	88.8	114	36.4	45 5	36	1.7	2.2
190	70 2	87 7	112	35 5	44 4	34	0.8	1.1
188	69.3	86.6	110	34.6	43.3	32	0.0	0.0

Boiling points of Water at different heights of the Barometer.

Barometer Inches.	Boiling Point Deg. of Faht.	Barometer Inches.	Boiling Point. Deg. of Faht.
31	213 57	28½	209.55
30½	212.79	28	208.69
30	212 00	27½	207.34
29½	211.20	27	206 96
29	210 38	In a vacuum more or less perfect from 98 to 100.	

Table containing the superficies and solid content of Spheres, from 1 to 12, and advancing by a tenth.

Diam.	Superficies.	Solidity.	Diam.	Superficies.	Solidity.
1.0	3.1416	.5236	3.5	38.4846	22.4493
.1	3.8013	.6969	.6	40.7151	24.4290
.2	4.5239	.9047	.7	43.0085	26.5219
.3	5.3093	1.1503	.8	45.3647	28.7309
.4	6.1575	1.4367	.9	47.7837	31.0594
.5	7.0686	1 7671	4.0	50 2656	33.5104
.6	8.0424	2.1446	.1	52 8102	36.0870
.7	9.0792	2.5724	.2	55.4178	38.7924
.8	10.1787	3.0536	.3	58.0881	41.6298
.9	11.3411	3.5913	.4	60.8213	44.6023
2.0	12 5664	4.1888	.5	63 6174	47.7130
.1	13.8544	4.8490	.6	66.4782	50.9651
.2	15.2053	5.5752	.7	69.3979	54.3617
.3	16.6190	6.3706	.8	72.3824	57.9059
.4	18 0956	7.2382	.9	75.4298	61.6010
.5	19·6350	8.1812	5.0	78:5400	65.4500
.6	21.2372	9.2027	.1	81.7130	69.4560
.7	22.9022	10 3060	.2	84.9488	73.6223
.8	24.6300	11.4940	.3	88.2475	77.9519
.9	26.4208	12 7700	.4	91.6090	82.4481
3.0	28.2744	14.1372	.5	95.0334	87.1139
.1	30.1907	15.5985	·6	98.5205	91.9525
.2	32.1699	17.1573	.7	102.0705	96.9670
.3	34.2120	18.8166	.8	105 6834	102.1606
.4	36.3168	20.5795	.9	109.3590	107.5364

Diam.	Superficies.	Solidity.	Diam.	Superficies.	Solidity.
6.0	113.0976	113.0976	9.0	254.4696	381.7044
.1	116.8989	118.8472	.1	260.1558	394.5697
.2	120.7631	124.7885	.2	265.9130	407.7210
.3	124.6901	130.9246	.3	271.7169	421.1613
.4	128.6799	137.2585	.4	277.5917	434.8937
.5	132.7326	143.7936	.5	283.5294	448.9215
.6	136.8480	150.5329	.6	289.5298	463.2477
.7	141.0264	157.4795	.7	295.5931	477.7755
.8	145.2675	164.6365	.8	301.7192	492.8081
.9	149.5715	172.0073	.9	307.9082	508.0485
7.0	153.9384	179.5948	10.0	314 1600	523 6000
.1	158.3680	187.4021	.1	320.4746	539.4656
.2	162.8605	195.4326	.2	326.8520	555.6485
.3	167.4158	203.6893	.3	333.2923	572.1518
.4	172.0340	212.1752	.4	339.7954	588 9784
.5	176.7150	220.8937	.5	346.3614	606.1324
.6	181.4588	229.8478	.6	352 9901	623.6159
.7	186.2654	239.0511	.7	359.6817	641.4325
.8	191.1349	248.4754	.8	366.4362	659.5852
.9	196.0672	258.1552	.9	373.2534	678.0771
8.0	201.0624	268.0832	11.0	380.1336	696.9116
.1	206.1203	278.2625	.1	387.0765	716.0915
.2	211.2411	288.6962	.2	394.0823	735.6200
.3	216.4248	299.3876	.3	401.1509	755 5008
.4	221.6712	310.3398	.4	408.2823	775.7364
.5	226.9806	321.5558	.5	415 4766	796.3301
.6	232.3527	333.0389	.6	422 7336	817.2851
.7	237.7877	344.7921	.7	430 0536	838.6045
.8	243.2855	356.8187	.8	437 4363	860 2915
.9	248.8461	369.1217	.9	444 8819	882.3492
			12.0	452.3904	904.7808

A TABLE

CONTAINING THE

CIRCUMFERENCES, SQUARES, CUBES,

AND

AREAS OF CIRCLES,

From $\frac{1}{8}$th to 100 *inches, advancing by a $\frac{1}{8}$th, and also the side of equal square, advancing at an equal ratio.*

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
1/16	.1963	.0039	.00024	.0030	.0554
1/8	.3927	.0156	.00195	.0122	.1107
3/16	.5890	.0351	.00659	.0276	.1661
1/4	.7854	.0625	.01562	.0490	.2115
5/16	.9817	.0976	.03051	.0767	.2669
3/8	1.1781	.1406	.05273	.1104	.3223
7/16	1.3744	.1914	.08374	.1503	.3771
1/2	1.5708	.25	.125	.1963	.4331
9/16	1.7671	.3164	.17797	.2485	.4995
5/8	1.9635	.3906	.24414	.3068	.5438
11/16	2.1598	.4726	.32495	.3712	.6093
3/4	2.3562	.5625	.42187	.4417	.6646
13/16	2.5525	.6601	.53637	.5185	.7200
7/8	2.7489	.7656	.66992	.6013	.7754
15/16	2.9452	.8789	.81397	.6903	.8308
1 *in.*	3.1416	1	1	.7854	.8862
1/16	3.3379	1.1289	1.19946	.8861	.9416
1/8	3.5343	1.2656	1.42381	.9940	.9969
3/16	3.7306	1.4101	1.67456	1.1075	1.0524
1/4	3.9270	1.5625	1.95312	1.2271	1.0775
5/16	4.1233	1.7226	2.26098	1.3529	1.1631
3/8	4.3197	1.8906	2.59960	1.4848	1.2185
7/16	4.5160	2.0664	2.97045	1.6229	1.2740
1/2	4.7124	2.25	3.375	1.7671	1.3293
9/16	4.9087	2.4414	3.81469	1.9175	1.3846
5/8	5.1051	2.6406	4.29101	2.0739	1.4401
11/16	5.3014	2.8476	4.80541	2.2365	1.4954
3/4	5.4978	3.0625	5.35937	2.4052	1.5508
13/16	5.6941	3.2851	5.95434	2.5801	1.6062
7/8	5.8905	3.5156	6.59179	2.7611	1.6616
15/16	6.0868	3.7539	7.27319	2.9483	1.7170
2 *in.*	6.2832	4	8	3.1416	1.7724
1/16	6.4795	4.2539	8.7736	3.3411	1.8278
1/8	6.6759	4.5156	9.5957	3.5465	1.8831
3/16	6.8722	4.7851	10.4675	3.7582	1.9385
1/4	7.0686	5.0625	11.3906	3.9760	1.9939
5/16	7.2649	5.3476	12.3663	4.2001	2.0493
3/8	7.4613	5.6406	13.3964	4.4302	2.1047
7/16	7.6576	5.9414	14.4822	4.6664	2.1601
1/2	7.8540	6.25	15.625	4.9087	2.2155
9/16	8.0503	6.5664	16.8265	5.1573	2.2709
5/8	8.2467	6.8906	18.0878	5.4119	2.3262
11/16	8.4430	7.2226	19.4108	5.6727	2.3816
3/4	8.6394	7.5625	20.7968	5.9395	2.4370
13/16	8.8357	7.9101	22.2472	6.2126	2.4924
7/8	9.0321	8.2656	23.7636	6.4918	2.5478
15/16	9.2284	8.6289	25.3474	6.7772	2.6032

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
3 *in.*	9.4248	9	27	7.0686	2.6586
1/16	9.6211	9.3789	28.7228	7.3662	2.7140
1/8	9.8175	9.7656	30.5175	7.6699	2.7694
3/16	10.0138	10.1601	32.3853	7.9798	2.8247
1/4	10.2102	10.5625	34.3281	8.2957	2.8801
5/16	10.4065	10.9726	36.3467	8.6179	2.9355
3/8	10.6029	11.3906	38.4433	8.9462	2.9909
7/16	10.7992	11.8164	40.6178	9.2806	3.0463
1/2	10.9956	12.25	42.875	9.6211	3.1017
9/16	11.1919	12.6914	45.2031	9.9678	3.1570
5/8	11.3883	13.1406	47.6347	10.3206	3.2124
11/16	11.5846	13.5976	49.9461	10.6796	3.2678
3/4	11.7810	14.0625	52.7343	11.0446	3.3232
13/16	11.9773	14.5351	55.3930	11.4159	3.3786
7/8	12.1737	15.1056	58.1855	11.7932	3.4340
15/16	12.3700	15.5039	61.0256	12.1768	3.4894
4 *in.*	12.5664	16	64.	12.5664	3.5448
1/16	12.7627	16.5039	67.0471	12.9622	3.6002
1/8	12.9591	17.0156	70.1894	13.3640	3.6555
3/16	13.1554	17.5351	73.4282	13.7721	3.7110
1/4	13.3518	18.0625	76.7656	14.1862	3.7663
5/16	13.5481	18.5976	80.2021	14.6066	3.8217
3/8	13.7445	19.1406	83.7402	15.0331	3.8771
7/16	13.9408	19.6914	87.3804	15.4657	3.9325
1/2	14.1372	20.25	91.125	15.9043	3.9880
9/16	14.3335	20.8164	94.9748	16.3492	4.0433
5/8	14.5299	21.3906	98.9316	16.8001	4.0987
11/16	14.7262	21.9726	101.8965	17.2573	4.1541
3/4	14.9226	22.5625	107.1718	17.7205	4.2095
13/16	15.1189	23.1601	111.4679	18.1900	4.2648
7/8	15.3153	23.7656	115.8574	18.6655	4.3202
15/16	15.5716	24.3789	120.2708	19.1472	4.3756
5 *in.*	15.7080	25	125	19.6350	4.4310
1/16	15.9043	25.6289	129.7463	20.1290	4.4864
1/8	16.1007	26.2656	134.6113	20.6290	4.5417
3/16	16.2970	26.9101	138.5961	21.1252	4.5971
1/4	16.4934	27.5625	144.7031	21.6475	4.6525
5/16	16.6897	28.2226	149.9306	22.1661	4.7079
3/8	16.8861	28.8906	155.2871	22.6907	4.7633
7/16	17.0824	29.5664	160.7673	23.2215	4.8187
1/2	17.2788	30.25	166.375	23.7583	4.8741
9/16	17.4751	30.9414	172.1115	24.3014	4.9294
5/8	17.6715	31.6406	177.9785	24.8505	4.9848
11/16	17.8678	32.3476	183.9669	25.4058	5.0402
3/4	18.0642	33.0625	190.1093	25.9672	5.0956
13/16	18.2605	33.7851	196.3759	26.5348	5.1510
7/8	18.4569	34.5156	202.7792	27.1085	5.2064
15/16	18.6532	35.2539	209.3130	27.6884	5.2618

Dia. or Root.	Circum.	Squarr.	Cube.	Area.	Side of = square.
6 *in.*	18.8496	36	216	28.2744	5.3172
1/16	19.0459	36.7539	222.8205	28.8665	5.3726
1/8	19.2423	37.5156	229.7832	29.4647	5.4280
3/16	19.4386	38.2851	236.8890	30.0798	5.4834
1/4	19.6350	39.0625	244.1406	30.6796	5.5388
5/16	19.8313	39.8476	249.2654	31.2964	5.5942
3/8	20.0277	40.6406	259.0839	31.9192	5.6495
7/16	20.2240	41.4414	256.7605	32.5481	5.7049
1/2	20.4204	42.25	274.625	33.1831	5.7603
9/16	20.6167	43.0664	282.6232	33.8244	5.8157
5/8	20.8131	43.8906	290.7753	34.4717	5.8711
11/16	21.0094	44.7226	299.0823	35.1252	5.9265
3/4	21.2058	45.5625	307.5468	35.7847	5.9819
13/16	21.4021	46.4101	316.1688	36.4505	6.0373
7/8	21.5985	47.2656	324.9511	37.1224	6.0927
15/16	21.7948	48.1289	333.8943	37.8005	6.1480
7 *in.*	21.9912	49	343	38.4846	6.2034
1/16	22.1875	49.8789	349.5702	39.1749	6.2588
1/8	22.3839	50.7656	361.7040	39.8713	6.3142
3/16	22.5802	51.6601	371.3070	40.5469	6.3 96
1/4	22.7766	52.5625	381.0781	41.2825	6.4350
5/16	22.9729	53.4726	391.0184	41.9974	6.4904
3/8	23.1693	54.3906	401.1308	42.7184	6.5358
7/16	23.3656	55.3164	411.4158	43.4455	6.5912
1/2	23.5620	56.25	421.875	44.1787	6.6465
9/16	23.7583	57.1914	432.5100	44.9181	6.7020
5/8	23.9547	58.1406	443.3222	45.6636	6.7573
11/16	24.1510	59.0976	454.3129	46.4153	6.8127
3/4	24.3474	60.0625	465.4843	47.1730	6.8681
13/16	24.5437	61.0351	476.8368	47.9370	6.9235
7/8	24.7401	62.0156	488.3730	48.7070	6.9789
15/16	24.9364	63.0039	500.0935	49.4833	7.0343
8 *in.*	25.1328	64	512	50.2656	7.0897
1/16	25.3291	65.0039	524.1939	51.0541	7.1451
1/8	25.5255	66.0156	536.3769	51.8486	7.2005
3/16	25.7218	67.0351	548.8499	52.8994	7.2559
1/4	25.9182	68.0625	561.5156	53.4562	7.3112
5/16	26.1145	69.0976	574.3739	54.2748	7.3666
3/8	26.3109	70.1406	587.4277	55.0885	7.4220
7/16	26.5072	71.1914	600.6775	55.9138	7.4774
1/2	26.7036	72.25	614.125	56.7451	7.5328
9/16	26.8999	73.3164	627.7717	57.5887	7.5882
5/8	27.0963	74.3906	641.6191	58.4264	7.6436
11/16	27.2926	75.4726	655.6683	59.7762	7.6990
3/4	27.4890	76.5625	669.9218	60.1321	7.7544
13/16	27.6853	77.6601	684.3797	60.9943	7.8098
7/8	27.8817	78.7656	699.0449	61.8625	7.8651
15/16	28.0780	79.8789	713.9177	62.7369	7.9205

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
9 *in.*	28.2744	81	729	63.6174	7.9760
1/16	28.4707	82.1289	744.2932	64.504!	8.0312
1/8	28.6671	83.2656	759.7988	65.3968	8.0866
3/16	28.8634	84.4101	775.5378	66.2957	8.1420
1/4	29.0598	85.5625	791.4531	67.2007	8.1974
5/16	29.2561	86.7226	807.8043	68.1120	8.2527
3/8	29.4525	87.8906	823.9746	69.0293	8.3081
7/16	29.6488	89.0664	840.5642	69.9528	8.3635
1/2	29.8452	90.25	857.375	70.8823	8.4190
9/16	30.0415	91.4414	874.3084	71.8181	8.4743
5/8	30.2379	92.6406	891.6660	72.7599	8.5297
11/16	30.4342	93.8476	909.1487	73.7079	8.5851
3/4	30.6306	95.0625	926.8593	74.6620	8.6405
13/16	30.8269	96.2851	944.7976	75.6223	8.6959
7/8	31.0233	97.5156	962.9667	76.5887	8.7513
15/16	31.2196	98.7539	981.3669	77.5613	8.8066
10 *in.*	31.4160	100	1000	78.5400	8.8620
1/16	31.6123	101.2539	1018.860	79.5248	8.9174
1/8	31.8087	102.5156	1037.970	80.5157	8.9728
3/16	32.0050	103.7851	1057.310	81.5128	9.0282
1/4	32.2014	105.0625	1076.890	82.5160	9.0836
5/16	32.3977	106.3476	1096.709	83.5254	9.1390
3/8	32.5941	107.6406	1116.771	84.5409	9.1943
7/16	32.7904	108.9414	1137.075	85.5626	9.2497
1/2	32.9868	110.25	1157.625	86.5903	9.3051
9/16	33.1831	111.5664	1178.420	87.6243	9.3605
5/8	33.3795	112.8906	1199.462	88.6643	9.4159
11/16	33.5758	114.2226	1220.755	89.7105	9.4713
3/4	33.7722	115.5625	1242.296	90.7627	9.5267
13/16	33.9685	116.9101	1264.090	91.8212	9.5821
7/8	34.1649	118.2656	1286.138	92.8858	9.6375
15/16	34.3612	119.6289	1308.430	93.9566	9.6929
11 *in.*	34.5576	121	1331	95.0334	9.7482
1/16	34.7539	122.3789	1353.816	96.1164	9.8036
1/8	34.9503	123.7656	1376.892	97.2053	9.8590
3/16	35.1466	125.1601	1400.228	98.3008	9.9144
1/4	35.3430	126.5625	1423.828	99.4021	9.9698
5/16	35.5393	127.9726	1447.690	100.5097	10.0252
3/8	35.7357	129.3906	1471.818	101.6234	10.0806
7/16	35.9320	130.8164	1496.412	102.7432	10.1360
1/2	36.1284	132.25	1520.875	103.8691	10.1914
9/16	36.3247	133.6914	1535.796	105.0012	10.2467
5/8	36.5211	135.1406	1571.009	106.1394	10.3021
11/16	36.7174	136.5976	1596.534	107.2838	10.3575
3/4	36.9138	138.0625	1622.234	108.4342	10.4130
13/16	37.1101	139.5351	1648.358	109.5909	10.4683
7/8	37.3065	141.0156	1674.560	110.7536	10.5237
15/16	37.5028	142.5039	1701.140	111.9226	10.5791

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
12 *in.*	37.6992	144	1728	113.0976	10.6345
1/16	37.8955	145.5039	1755.160	114.2788	10.6899
1/8	38.0919	147.0156	1782.564	115.4660	10.7453
3/16	38.2882	148.5351	1810.271	116.6645	10.8007
1/4	38.4846	150.0625	1838.265	117.8590	10.8560
5/16	38.6809	151.5976	1866.539	119.0648	10.9114
3/8	38.8773	153.1406	1895.115	120.2766	10.9668
7/16	39.0736	154.6914	1923.974	121.4946	11.0222
1/2	39.2700	156.25	1953.125	122.7187	11.0776
9/16	39.4663	157.8164	1982.568	123.9490	11.1339
5/8	39.6627	159.3906	2012.306	125.1854	11.1884
11/16	39.8590	160.9726	2042.339	126.4479	11.2437
3/4	40.0554	162.5625	2072.671	127.6765	11.2991
13/16	40.2517	164.1601	2103.301	128.8999	11.3544
7/8	40.4481	165.7656	2134.232	130.1923	11.4099
15/16	40.6444	167.3789	2165.514	131.4279	11.4652
13 *in.*	40.8408	169	2197	132.7326	11.5206
1/16	41.0371	170.6289	2228.840	134.0120	11.5760
1/8	41.2338	172.2656	2260.986	135.2974	11.6314
3/16	41.4298	173.9101	2293.439	136.5890	11.6868
1/4	41.6262	175.5625	2326.203	137.8867	11.7422
5/16	41.8225	177.2226	2359.275	139.1907	11.7976
3/8	42.0189	178.8906	2392.661	140.5007	11.8530
7/16	42.2152	180.5664	2426.361	141.8169	11.9083
1/2	42.4116	182.25	2460.375	143.1391	11.9637
9/16	42.6079	183.9414	2494.705	144.4726	12.0191
5/8	42.8043	185.6406	2529.353	145.8021	12.0745
11/16	43.0006	187.3476	2564.321	147.1428	12.1299
3/4	43.1970	189.0625	2599.609	148.4896	12.1853
13/16	43.3933	190.7851	2634.819	149.8426	12.2407
7/8	43.5897	192.5156	2671.154	151.2017	12.2961
15/16	43.7860	194.2539	2707.413	152.5670	12.3515
14 *in.*	43.9824	196	2744	153.9384	12.4068
1/16	44.1787	197.7539	2780.914	155.3159	12.4622
1/8	44.3751	199.5156	2818.157	156.6995	12.5176
3/16	44.5714	201.2851	2855.732	158.0893	12.5730
1/4	44.7676	203.0625	2893.640	159.4852	12.6284
5/16	44.9641	204.8476	2931.781	160.8374	12.6838
3/8	45.1605	206.6406	2970.458	162.2956	12.7392
7/16	45.3568	208.4414	3009.372	163.7099	12.7946
1/2	45.5532	210.25	3048.625	165.1303	12.8500
9/16	45.7495	212.0664	3088 217	166.5569	12.9053
5/8	45.9459	213.8906	3128.150	167.9896	12.9607
11/16	46.1422	215.7226	3168.425	169.4285	13.0161
3/4	46.3386	217.5625	3209.046	170.8735	13.0715
13/16	46.5349	219.4101	3250.012	172.3247	13.1270
7/8	46.7313	221.2656	3291.325	173.7820	13.1823
15/16	46.9276	223.1289	3332.988	175.2455	13.2377

Dia. or Rost.	Circum.	Square.	Cube.	Area.	Side of = square.
15 *in.*	47.1240	225	3375	176.7150	13.2930
1/16	47.3203	226.8789	3414.781	178.1907	13.3484
1/8	47.5167	228.7656	3460.079	179.6725	13.4038
3/16	47.7130	230.6601	3503.150	181.1105	13.4592
1/4	47.9094	232.5625	3546.578	182.6545	13.5146
5/16	48.1057	234.4726	3590.361	184.1548	13.5700
3/8	48.3021	236.3906	3633.505	185.6612	13.6254
7/16	48.4984	238.3164	3679.009	187.1737	13.6608
1/2	48.6948	240.25	3723.875	188.6923	13.7361
9/16	48.8911	242.1914	3769.103	190.2171	13.7915
5/8	49.0875	244.1406	3814.696	191.7480	13.8470
11/16	49.2838	246.0976	3860.856	193.3351	13.9023
3/4	49.4802	248.0625	3906.984	194.8282	13.9577
13/16	49.6765	250.0351	3953.680	196.3776	14.0131
7/8	49.8729	252.0156	4000.747	197.9330	14.0685
15/16	50.0692	254.0039	4048.187	199.4947	14.1240
16 *in.*	50.2656	256	4096	201.0624	14.1792
1/16	50.4619	258.0039	4144.187	202.6363	14.2346
1/8	50.6583	260.0156	4192.751	204.2162	14.2900
3/16	50.8546	262.0351	4241.693	205.8024	14.3454
1/4	51.0510	264.0625	4291.015	207.3946	14.4008
5/16	51.2473	266.0976	4360.717	208.9931	14.4561
3/8	51.4437	268.1406	4390.802	210.5976	14.5115
7/16	51.6400	270.1914	4441.271	212.2083	14.5670
1/2	51.8364	272.25	4492.125	213.8251	14.6223
9/16	52.0327	274.3164	4544.366	215.4481	14.6777
5/8	52.2291	276.3906	4594.993	217.0772	14.7321
11/16	52.4254	278.4726	4657.011	218.7124	14.7885
3/4	52.6218	280.5625	4699.421	220.3537	14.8439
13/16	52.8181	282.6601	4752.223	222.0013	14.8993
7/8	53.0145	284.7656	4805.419	223.6549	14.9547
15/16	53.2108	286.8789	4859.011	225.3147	15.0101
17 *in.*	53.4072	289	4913	226.9806	15.0654
1/16	53.6035	291.1289	4967.286	228.6527	15.1208
1/8	53.7999	293.2656	5022.173	230.3308	15.1762
3/16	53.9962	295.4101	5077.361	232.0151	15.2316
1/4	54.1926	297.5625	5132.953	233.7055	15.2869
5/16	54.3889	299.7226	5188.947	235.4022	15.3424
3/8	54.5853	301.8906	5245.349	237.1049	15.3977
7/16	54.7816	304.0664	5302.157	238.8138	15.4531
1/2	54.9780	306.25	5359.375	240.5287	15.5085
9/16	55.1743	308.4414	5419.002	242.2499	15.5639
5/8	55.3707	310.6406	5475.040	243.9771	15.6193
11/16	55.5670	312.8476	5533.493	245.7105	15.6747
3/4	55.7634	315.0625	5592.359	247.4500	15.7301
13/16	55.9597	317.2851	5651.640	249.1952	15.7855
7/8	56.1561	319.5156	5711.341	250.9475	15.8408
15/16	56.3524	321.7539	5771.460	252.7050	15.8962

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
18 *in*	56.5488	324	5832	254.4696	15.9516
1/16	56.7451	326.2539	5892.961	256.2398	16.0070
1/8	56.9415	328.5156	5954.345	258.0161	16.0624
3/16	57.1378	330.7851	6016.154	259.7986	16.1178
1/4	57.3342	333.0625	6078.390	261.5872	16.1732
5/16	57.5305	335.3476	6141.053	263.3820	16.2285
3/8	57.7269	337.6406	6204.146	265.1829	16.2839
7/16	57.9232	339.9414	6267.669	266.9900	16.3393
1/2	58.1196	342.25	6331.625	268.8031	16.3947
9/16	58.2159	344.5664	6396.010	270.6225	16.4501
5/8	58.5123	346.8906	6460.837	272.4479	16.5055
11/16	58.7806	349.2226	6566.497	274.2895	16.5609
3/4	58.9056	351.5625	6591.796	276.1171	16.6163
13/16	59.1013	353.9101	6658.933	277.9610	16.6717
7/8	59.2977	356.2656	6724.513	279.8110	16.7270
15/16	59.4940	358.6289	6791.534	281.1672	16.7824
19 *in.*	59.6904	361	6859	283.5294	16.8378
1/16	59.8867	363.3789	6926.910	285.3978	16.8932
1/8	60.0831	365.7656	6995.267	287.2723	16.9486
3/16	60.2794	368.1601	7065.672	289.4030	17.0040
1/4	60.4758	370.5625	7132.328	291.0397	17.0600
5/16	60.6721	372.9726	7203.033	292.9324	17.1147
3/8	60.8685	375.3906	7273.192	294.8312	17.1701
7/16	61.0648	377.8164	7343.785	296.7367	17.2255
1/2	61.2612	380.25	7414.875	298.6483	17.2809
9/16	61.4575	382.6914	7486.410	300.5658	17.3363
5/8	61.6539	385.1406	7558.384	302.4894	17.3917
11/16	61.8502	387.5976	7630.827	304.4192	17.4471
3/4	62.0466	390.0625	7703.734	306.3550	17.5025
13/16	62.2429	392.5351	7777.111	308.2971	17.5579
7/8	62.4393	395.0156	7850.935	310.2452	17.6132
15/16	62.6356	397.5039	7925.234	312.1996	17.6686
20 *in.*	62.8320	400	8000	314.1600	17.7240
1/16	63.0283	402.5039	8075.234	316.1266	17.7794
1/8	63.2247	405.0156	8150.939	318.0992	17.8348
3/16	63.4210	407.5351	8227.114	320.0781	17.8902
1/4	63.6174	410.0625	8303.765	322.0630	17.9456
5/16	63.8137	412.5976	8380.888	324.0542	18.0010
3/8	64.0101	415.1406	8458.489	326.0514	18.0563
7/16	64.2064	417.6914	8536.567	328.0548	18.1117
1/2	64.4028	420.25	8615.125	330.0643	18.1671
9/16	64.5991	422.8164	8694.162	332.0800	18.2225
5/8	64.7955	425.3906	8773.681	334.1018	18.2779
11/16	64.9918	427.9726	8853.683	336.1297	18.3333
3/4	65.1882	430.5625	8934.171	338.1637	18.3887
13/16	65.3845	433.1601	9015.144	340.2040	18.4441
7/8	65.5809	435.7656	9096.607	342.2503	18.4995
15/16	65.7772	438.3789	9178.558	344.3028	18.5549

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
21 *in.*	65.7936	441	9261	346.3614	18.6102
1/16	66.1699	443.6289	9343.933	348.4267	18.6656
1/8	66.3663	446.2656	9427.360	350.4970	18.7210
3/16	66.5626	448.9101	9511.282	352.5740	18.7764
1/4	66.7590	451.5625	9595.703	354.6571	18.8318
5/16	66.9553	454.2226	9680.617	356.7465	18.8872
3/8	67.1517	456.8906	9766.036	358.8419	18.9425
7/16	67.3480	459.5664	9853.954	360.9435	18.9979
1/2	67.5444	462.25	9938.375	363.0511	19.0533
9/16	67.7407	464.9414	10025.29	365.1650	19.1087
5/8	67.9371	467.6406	10112.72	367.2849	19.1641
11/16	68.1334	470.3476	10200.66	369.4110	19.2195
3/4	68.3298	473.0625	10289.11	371.5432	19.2749
13/16	68.5261	475.7851	10378.06	373.6816	19.3303
7/8	68.7225	478.5156	10467.52	375.8261	19.3857
15/16	68.9188	481.2509	10557.54	377.9768	19.4410
22 *in.*	69.1152	484	10648	380.1336	19.4964
1/16	69.3115	486.7539	10739.00	382.2965	19.5518
1/8	69.5079	489.5156	10830.53	384.4655	19.6072
3/16	69.7042	492.2851	10922.57	386.6907	19.6626
1/4	69.9006	495.0625	11015.14	388.8220	19.7180
5/16	70.0969	497.8476	11108.22	391.0095	19.7734
3/8	70.2933	500.6406	11201.83	393.2031	19.8287
7/16	70.4806	503.4414	11295.96	395.4029	19.8841
1/2	70.6860	506.25	11390.62	397.6087	19.9395
9/16	70.8823	509.0664	11485.81	399.8207	19.9949
5/8	71.0787	511.8906	11581.52	402.0388	20.0503
11/16	71.2750	514.7226	11677.76	404.2631	20.1057
3/4	71.4714	517.5625	11774.54	406.4935	20.1611
13/16	71.6677	520.4101	11871.85	408.7301	20.2165
7/8	71.8641	523.2656	11969.70	410.9728	20.2719
15/16	72.0604	526.1289	12068.08	413.2317	20.3272
23 *in.*	72.2568	529	12167	415.4766	20.3826
1/16	72.4531	531.8789	12266.45	417.7377	20 4380
1/8	72.6495	534.7656	12366.45	420.0049	20.4934
3/16	72.8458	537.6601	12466.99	422.2783	20.5490
1/4	73.0422	540.5625	12568.07	424.5577	20.6042
5/16	73.2385	543.4726	12669.70	426.3434	20.6596
3/8	73.4349	546.3906	12771.88	429.1352	20.7150
7/16	73.6312	549.3164	12874 60	431.4331	20.7703
1/2	73.8276	552.25	12977.87	433.7371	20.8257
9/16	74.0239	555.1914	13081.69	436.0473	20.8811
5/8	74.2203	558.1406	13185.98	438.3636	20 9365
11/16	74.4166	561.0976	13290.99	440.6811	20.9919
3/4	74.6130	564.0625	13396.48	443.0146	21.0473
13/16	74.8093	567.0351	13502.52	445 3539	21.1027
7/8	75.0057	570.0156	13609.12	447.6992	21.1581
15/16	75.2020	573.0039	13716.28	450.0418	21.2134

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
24 *in.*	75.3984	576	13824	452.3904	21.2688
1/16	75.5947	579.0039	13932.281	454.7497	21.3242
1/8	75.7911	582.0156	14041.126	457.1150	21.3796
3/16	75.9874	585.0351	14150.536	459.4866	21.4350
1/4	76.1838	588.0625	14260.515	461.8642	21.4904
5/16	76.3801	591.0976	14371.060	464.2481	21.5558
3/8	76.5765	594.1406	14482.177	466.6380	21.6012
7/16	76.7728	597.1914	14593.864	469.0341	21.6566
1/2	76.9692	600.25	14706.125	471.4363	21.7119
9/16	77.1655	603.3164	14818.959	473.8447	21.7673
5/8	77.3619	606.3906	14932.368	476.2592	21.8227
11/16	77.5582	609.4726	15046.354	478.6798	21.8781
3/4	77.7546	612.5625	15160.921	481.1065	21.9335
13/16	77.9509	615.6601	15285.065	483.5395	21.9889
7/8	78.1473	618.7656	15391.794	485.9785	22.0443
15/16	78.3436	621.8789	15508.105	488.4237	22.0997
25 *in.*	78.5400	625	15625	490.8750	22.1550
1/16	78.7363	628.1289	15742.480	493.3325	22.2104
1/8	78.9327	631.2656	15860.548	495.7960	22.2658
3/16	79.1290	634.4101	15979.204	498.2657	22.3212
1/4	79.3254	637.5625	16098.453	500.7415	22.3766
5/16	79.5217	640.7226	16218.290	503.2236	22.4320
3/8	79.7181	643.8906	16338.323	505.7117	22.4873
7/16	79.9144	647.0664	16459.751	508.2060	22.5427
1/2	80.1108	650.25	16581.375	510.7063	22.5981
9/16	80.3071	653.4414	16703.595	513.2129	22.6535
5/8	80.5035	656.6406	16826.415	515.7255	22.7089
11/16	80.6998	659.8476	16949.824	518.2443	22.7643
3/4	80.8962	663.0625	17073.859	520.7692	22.8197
13/16	81.0925	666.2851	17195.482	523.3003	22.8751
7/8	81.2889	669.5156	17323.716	525.8375	22.9305
15/16	81.4852	672.7539	17449.552	528.3809	22.9858
26 *in.*	81.6816	676	17576	530.9304	23.0412
1/16	81.8779	679.2539	17703.054	533.4860	23.0966
1/8	82.0743	682.5156	17830.720	536.0477	23.1520
3/16	82.2706	685.7851	17924.708	538.6156	23.2074
1/4	82.4670	689.0625	18087.890	541.1896	23.0628
5/16	82.6633	692.3476	18217.396	543.7698	23.3182
3/8	82.8597	695.6406	18347.520	546.3561	23.3735
7/16	83.0560	698.9414	18468.254	548.9486	23.4289
1/2	83.2524	702.25	18609.625	551.5471	23.4843
9/16	83.4487	705.5664	18751.607	554.1519	23.5397
5/8	83.6451	708.8906	18874.212	556.7627	23.5951
11/16	83.8414	712.2226	19007.440	559.3797	23.6505
3/4	84.0378	715.5625	19141.296	562.0027	23.7088
13/16	84.2341	718.9101	19275.767	564.6320	23.7613
7/8	84.4305	722.2656	19410.888	567.2674	23.8166
15/16	84.6268	725.6289	19546.628	569.4090	23.8721

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
27 in.	84.8232	729	19683	572.5566	23.9274
1/16	85.0195	732.3789	19820.003	575.2104	23.9828
1/8	85.2159	735.7656	19957.642	577.8703	24.0382
3/16	85.4122	739.1601	20058.957	580.5364	24.0936
1/4	85.6086	742.5625	20234.828	583.2085	24.1490
5/16	85.8049	745.9726	20374.376	585.8869	24.2044
3/8	86.0013	749.3906	20514.567	588.5714	24.2598
7/16	86.1976	752.8164	20655.399	591.2620	24.3192
1/2	86.3940	756.25	20796.875	593.9587	24.3705
9/16	86.5903	759.6914	20942.994	596.6616	24.4269
5/8	86.7867	763.1406	21081.759	599.3706	24.4813
11/16	86.9830	766.5976	21225.171	602.0858	24.5067
3/4	87.1794	770.0625	21369.234	604.8070	24.5921
13/16	87.3757	773.5351	21514.044	607.5345	24.6475
7/8	87.5721	777.0156	21659.309	610.2680	24.7029
15/16	87.7684	780.5039	21805.327	613.0078	24.7583
28 in.	87.9648	784	21952	615.7536	24.8136
1/16	88.1611	787.5039	22099.328	618.5051	24.8690
1/8	88.3575	791.0156	22247.313	621.2636	24.9244
3/16	88.5538	794.5351	22395.958	624.0279	24.9797
1/4	88.7502	798.0625	22545.265	626.7982	25.0351
5/16	88.9465	801.5976	22695.231	629.5748	25.0905
3/8	89.1429	805.1406	22845.864	632.3574	25.1459
7/16	89.3392	808.6914	22997.161	635.1462	25.2013
1/2	89.5356	812.25	23149.125	637.9411	25.2567
9/16	89.7319	815.8164	23301.755	640.7422	25.3121
5/8	89.9283	819.3906	23455.056	643.5494	25.3675
11/16	90.1246	822.9726	23609.026	646.3627	25.4229
3/4	90.3210	826.5625	23763.671	649.1821	25.4783
13/16	90.5173	830.1601	23919.007	652.0078	25.5337
7/8	90.7137	833.7656	24074.981	654.8395	25.5891
15/16	90.9100	837.3789	24231.651	657.6774	25.6446
29 in.	91.1064	841	24389	660.5214	25.6998
1/16	91.3027	844.6289	24547.027	663.3716	25.7524
1/8	91.4991	848.2656	24705.735	666.2278	25.8106
3/16	91.6954	851.9101	24865.126	669.0902	25.8660
1/4	91.8918	855.5625	25025.203	671.9587	25.9214
5/16	92.0081	859.2226	25195.962	674.8335	26.9768
3/8	92.2845	862.8906	25347.411	677.7143	26.0325
7/16	92.4803	866.5664	25519.548	680.6013	26.0876
1/2	92.6772	870.25	25672.375	683.4943	26.1429
9/16	92.8735	873.9414	25835.892	686.3936	26.1983
5/8	93.0699	877.6406	26000.102	689.2989	26.2537
11/16	93.2662	881.3476	26165.006	692.2104	26.3091
3/4	93.4626	885.0625	26330.609	695.1280	26.3645
13/16	93.6589	888.7851	26496.905	698.0518	26.4799
7/8	93.8553	892.5156	26663.903	700.9817	26.4783
15/16	94.0516	896.2539	26831.521	703.9178	26.5307

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of square.
30 in.	94.2480	900	27000	706.8600	26.5860
1/16	94.4443	903.7539	27249.101	709.8083	26.6413
1/8	94.6407	907.5156	27338.907	712.7627	26.6967
3/16	94.8370	911.2851	27463.846	715.7233	26.7521
1/4	95.0334	915.0625	27680.640	718.6900	26.8075
5/16	95.2297	918.8476	27852.567	721.6629	26.8629
3/8	95.4261	922.6406	28025.208	724.6419	26.9183
7/16	95.6224	926.4414	28198.561	727.6271	26.9737
1/2	95.8188	930.25	28372.625	730.6183	27.0291
9/16	96.0151	934.0664	28547.504	733.6158	27.0844
5/8	96.2115	937.8906	28722.899	736.6193	27.1398
11/16	96.4078	941.7226	28899.122	739.6290	27.1952
3/4	96.6042	945.5625	29076.046	742.6447	27.2506
13/16	96.8005	949.4101	29253.698	745.6667	27.3060
7/8	96.9969	953.2656	29432.075	748.6948	27.3614
15/16	97.1932	957.1289	29606.975	751.7291	27.4168
31 in.	97.3896	961	29791	754.7694	27.4722
1/16	97.5859	964.8789	29979.550	757.8159	27.5275
1/8	97.7823	968.7656	30152.829	760.8685	27.5829
3/16	97.9786	972.6601	30296.203	763.9273	27.6383
1/4	98.1750	976.5625	30517.578	766.9921	27.6937
5/16	98.3713	980.4726	30701.048	770.0632	27.7491
3/8	98.5677	984.3906	30885.255	773.1404	27.8045
7/16	98.7648	988.3164	30946.712	776.2237	27.8599
1/2	98.9684	992.25	31255.875	779.3131	27.9153
9/16	99.1567	996.1914	31442.191	782.4087	27.9706
5/8	99.3531	1000.140	31629.446	785.5104	28.0260
11/16	99.5494	1004.097	31817.542	788.6183	28.0814
3/4	99.7458	1008.062	32005.984	791.7322	28.1368
13/16	99.9421	1012.035	32195.366	794.8524	28.1922
7/8	100.1385	1016.015	32385.497	797.9786	28.2476
15/16	100.3348	1020.003	32576.375	801.1111	28.3030
in.	100.5312	1024	32768	804.2496	28.3584
1/16	100.7275	1028.003	32960.375	807.3943	28.4137
1/8	100.9240	1032.015	33153.501	810.5450	28.4691
3/16	101.1202	1036.035	33295.578	813.7020	28.5245
1/4	101.3166	1040.062	33542.015	816.8650	28.5799
5/16	101.5130	1044.097	33737.403	820.0343	28.6352
3/8	101.7093	1048.840	33956.314	823.2096	28.6912
7/16	101.9056	1052.191	34130.258	826.3911	28.7466
1/2	102.1020	1056.25	34328.125	829.5787	28.8015
9/16	102.2983	1060.316	34526.552	832.7725	28.8568
5/8	102.4947	1064.390	34725.743	835.9724	28.9122
11/16	102.6910	1068.472	34925.698	839.1784	28.9676
3/4	102.8874	1072.562	35026.421	842.3905	29.0230
13/16	103.0837	1076.660	35327.909	845.6089	29.0784
7/8	103.2801	1080.765	35530.169	848.8333	29.1338
15/16	103.4764	1084.878	35733.198	852.0639	29.1892

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
33 *in.*	103.6728	1089	35937	855.3006	29.2446
1/16	103.8691	1093.129	36141.577	858.5436	29.2999
1/8	104.0655	1097.265	36354.928	861.7924	29.3553
3/16	104.2618	1101.410	36553.144	865.0475	29.4107
1/4	104.4582	1105.562	36759.944	868.3087	29.4661
5/16	104.6545	1109.722	36967.614	871.5760	29.5215
3/8	104.8509	1113.890	37256.088	874.8497	29.5769
7/16	105.0472	1118.066	37385.332	878.1290	29.6323
1/2	105.2436	1122.25	37595.375	881.4151	29.6877
9/16	105.4399	1126.441	37806.176	884.7070	29.7431
5/8	105.6363	1130.640	38017.784	888.0051	29.7985
11/16	105.8326	1134.847	38230.158	891.3090	29.8539
3/4	106.0290	1139.062	38443.352	894.6196	29.9092
13/16	106.2253	1143.285	38657.324	897.9360	29.9646
7/8	106.4217	1147.515	38872.088	901.2587	30.0200
15/16	106.6180	1151.754	39087.651	904.5875	30.0754
34 *in.*	106.8144	1156	39304	907.9224	30.1308
1/16	107.0107	1160.254	39521.152	911.2645	30.1862
1/8	107.2071	1164.515	39738.288	914.6105	30.2416
3/16	107.4034	1168.785	39957.837	917.9640	30.2970
1/4	107.5998	1173.062	40177.384	921.3232	30.3523
5/16	107.7961	1177.347	40397.719	924.6883	30.4077
3/8	107.9925	1181.640	40618.888	928.0605	30.4631
7/16	108.1888	1185.941	40840.843	931.4380	30.5185
1/2	108.3852	1190.25	41063.625	934.8223	30.5739
9/16	108.5815	1194.566	41287.187	938.2121	30.6293
5/8	108.7779	1198.890	41511.576	941.6087	30.6847
11/16	108.9742	1203.222	41736.763	945.0110	30.7400
3/4	109.1706	1207.562	41962.792	948.4195	30.7954
13/16	109.3669	1211.910	42189.617	951.8341	30.8508
7/8	109.5633	1216.265	42417.256	955.2550	30.9062
15/16	109.7596	1220.629	42695.725	958.6820	30.9616
35 *in.*	109.9560	1225	42875	962.1150	31.0170
1/16	110.1523	1229.379	43105.081	965.5542	31.0724
1/8	110.3487	1233.765	43352.016	968.9995	31.1278
3/16	110.5450	1238.160	43567.755	972.4510	31.1831
1/4	110.7414	1242.562	43800.320	975.9085	31.2386
5/16	110.9377	1246.968	44033.557	979.3686	31.2939
3/8	111.1341	1251.390	44267.944	982.8422	31.3493
7/16	111.3304	1255.816	44502.979	986.3180	31.4047
1/2	111.5268	1260.25	44738.875	989.8003	31.4601
9/16	111.7231	1264.591	44972.017	993.2097	31.5155
5/8	111.9195	1269.140	45213.120	996.7830	31.5709
11/16	112.1158	1273.597	45451.493	1000.3472	31.6263
3/4	112.3122	1278.062	45690.728	1003.7992	31.6817
13/16	112.5086	1282.535	45930.784	1007.3030	31.7370
7/8	112.7049	1287.015	46171.680	1010.8220	31.7924
15/16	112.9012	1291.504	46413.425	1014.3472	31.8478

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
36 *in.*	113.0976	1296	46656	1017.8784	31.9032
1/16	113.2939	1306.503	47115.796	1021.4158	31.9585
1/8	113.4903	1308.015	47252.063	1024.9592	32.0139
3/16	113.6866	1309.535	47388.801	1028.5089	32.0693
1/4	113.8830	1314.062	47634.765	1032.0646	32.1247
5/16	114.0793	1318.597	47881.565	1035.6266	32.1801
3/8	114.2757	1323.140	48129.239	1039.1946	32.2355
7/16	114.4720	1327.691	48377.795	1042.7913	32.2909
1/2	114.6684	1332.25	48627.125	1046.3941	32.3463
9/16	114.8647	1336.816	48877.349	1049.9581	32.4016
5/8	115.0611	1341.390	49128.430	1053.5281	32.4570
11/16	115.2572	1345.972	49380.360	1057.1269	32.5124
3/4	115.4538	1350.562	49633.171	1060.7317	32.5678
13/16	115.6501	1355.160	49886.831	1064.3428	32.6232
7/8	115.8465	1359.765	50141.356	1067.9599	32.6786
15/16	116.0428	1364.378	50396.745	1071.5832	32.7340
37 *in.*	116.2392	1369	50653	1075.2126	32.7894
1/16	116.4355	1373.628	51010.121	1078.8482	32.8447
1/8	116.6319	1378.265	51168.110	1082.4898	32.9001
3/16	116.8282	1382.910	51426.969	1086.1376	32.9555
1/4	117.0246	1387.562	51686.703	1089.7915	33.0109
5/16	117.2209	1392.222	52447.305	1093.4517	33.0663
3/8	117.4173	1396.890	52208.786	1097.1179	33.0217
7/16	117.6136	1401.566	52471.142	1100.7903	33.1771
1/2	117.8100	1406.25	52734.375	1104.4687	33.2325
9/16	118.0063	1410.941	52998.497	1108.1534	33.2878
5/8	118.2027	1415.640	53263.477	1111.8441	33.3432
11/16	118.3990	1420.347	53517.892	1115.5410	33.3986
3/4	118.5954	1425.062	53796.109	1119.2440	33.4540
13/16	118.7917	1429.785	54063.629	1122.9532	33.5094
7/8	118.9881	1434.515	54332.278	1126.6685	33.5648
15/16	119.1844	1439.253	54601.694	1130.3900	33.6202
38 *in.*	119.3808	1444	54872	1134.1176	33.6756
1/16	119.5771	1448.753	55143.195	1137.8513	33.7309
1/8	119.7735	1453.515	55415.282	1141.5911	33.7863
3/16	119.9698	1458.285	55687.252	1145.3371	33.8417
1/4	120.1662	1463.062	55962.140	1149.0892	33.8971
5/16	120.3625	1467.847	56236.915	1152.8475	33.9525
3/8	120.5589	1472.640	56512.583	1156.6119	34.0079
7/16	120.7552	1477.441	56789.213	1160.3825	34.0633
1/2	120.9516	1482.25	57066.625	1164.1591	34.1187
9/16	121.1479	1487.066	57244.998	1167.9420	34.1740
5/8	121.3443	1491.890	57624.274	1171.7309	34.2294
11/16	121.5406	1496.722	57904.455	1175.5260	34.2848
3/4	121.7370	1501.562	58185.546	1179.3271	34.3402
13/16	121.9333	1506.410	58467.542	1183.1345	34.3956
7/8	122.1297	1511.265	58750.450	1186.9480	34.4510
15/16	122.3260	1516.128	59034.251	1190.7677	34.5064

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
39 *in.*	122.5224	1521	59319	1194.5934	34.5618
1/16	122.7187	1525.878	59604.445	1198.4253	34.6171
1/8	122.9151	1530.765	59891.204	1202.2633	34.6725
3/16	123.1114	1535.660	60178.680	1206.1075	34.7279
1/4	123.3078	1540.562	60466.078	1209.9577	34.7833
5/16	123.5041	1545.472	60756.391	1213.8142	34.8387
3/8	123.7005	1550.390	61046.629	1217.6768	34.8941
7/16	123.8968	1555.316	61337.798	1221.5455	34.9495
1/2	124.0932	1560.25	61629.875	1225.4203	35.0049
9/16	124.2895	1565.191	61922.884	1229.3013	35.0602
5/8	124.4859	1570.140	62216.822	1233.1884	35.1156
11/16	124.6822	1575.097	62511.686	1237.0817	35.1710
3/4	124.8786	1580.062	62807.484	1240.9810	35.2264
13/16	125.0749	1585.035	63304.209	1244.8866	35.2818
7/8	125.2713	1590.015	63401.872	1248.7982	35.3372
15/16	125.4676	1595.003	63700.468	1252.7161	35.3926
40 *in.*	125.6640	1600	64000	1256.6400	35.4480
1/16	125.8603	1605.003	64300.468	1260.5701	35.5033
1/8	126.0567	1610.015	64601.875	1264.5062	35.5587
3/16	126.2530	1615.035	64894.223	1268.4486	35.6141
1/4	126.4494	1620.062	65207.515	1272.3970	35.6695
5/16	126.6457	1625.097	65511.747	1276.3517	35.7249
3/8	126.8421	1630.140	65816.926	1280.3124	35.7803
7/16	127.0384	1635.191	66123.052	1284.2793	35.8357
1/2	127.2348	1640.25	66430.125	1288.2523	35.8911
9/16	127.4311	1645.316	66738.146	1292.2315	35.9464
5/8	127.6275	1650.390	67047.110	1296.2168	36.0018
11/16	127.8238	1655.472	67357.041	1300.2082	36.0572
3/4	128.0202	1660.562	67667.925	1304.2057	36.1126
13/16	128.2165	1665.660	67971.590	1308.2095	36.1680
7/8	128.4129	1670.765	68292.539	1312.2193	36.2234
15/16	128.6092	1675.878	68706.292	1316.2353	36.2788
41 *in.*	128.8056	1681	68921	1320.2574	36.3342
1/16	129.0019	1686.128	69236.667	1324.2857	36.3895
1/8	129.1983	1691.265	69553.297	1328.3200	36.4449
3/16	129.3946	1696.410	69870.890	1332.3605	36.5003
1/4	129.5910	1701.562	70189.453	1336.4071	36.5557
5/16	129.7873	1706.722	70508.977	1340.4600	36.6111
3/8	129.9837	1711.890	70829.473	1344.5189	36.6665
7/16	130.1800	1717.066	71150.938	1348.5840	36.7219
1/2	130.3764	1722.25	71473.375	1352.6551	36.7773
9/16	130.5727	1727.441	71703.482	1356.7325	36.8326
5/8	130.7691	1732.640	72121.164	1360.8159	36.8880
11/16	130.9654	1737.847	72444.541	1364.9055	36.9434
3/4	131.1618	1743.062	72772.859	1369.0012	36.9988
13/16	131.3581	1748.285	73100.170	1373.1031	37.0542
7/8	131.5545	1753.515	73428.465	1377.2111	37.1096
15/16	131.7508	1758.753	73757.791	1381.3253	37.1650

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
42 *in.*	131.9472	1764	74088	1385.4456	37.2204
1/16	132.1435	1769.253	74419.242	1389.5720	37.2757
1/8	132.3399	1774.515	74751.469	1393.7045	37.3311
3/16	132.5362	1779.785	75084.683	1397.8432	37.3865
1/4	132.7326	1785.062	75418.890	1401.9880	37.4419
5/16	132.9289	1790.347	75711.770	1406.1390	37.4973
3/8	133.1253	1795.640	76090.270	1410.2961	37.5527
7/16	133.3216	1800.941	76426.450	1414.4594	37.6081
1/2	133.5180	1806.25	76765.625	1418.6287	37.6635
9/16	133.7143	1811.566	77304.794	1422.8043	37.7188
5/8	133.9107	1816.890	77444.961	1426.9859	37.7742
11/16	134.1070	1822.222	77786.127	1431.1737	37.8296
3/4	134.3034	1827.562	78128.296	1435.3675	37.8850
13/16	134.4997	1832.910	78471.463	1439.5676	37.9404
7/8	134.6961	1838.265	78815.637	1443.7738	37.9958
15/16	134.8924	1843.628	79160.815	1447.9862	38.0512
43 *in.*	135.0888	1849	79507	1452.2046	38.1066
1/16	135.2851	1854.378	79854.191	1456.4292	38.1619
1/8	135.4815	1859.765	80202.391	1460.6599	38.2173
3/16	135.6778	1865.160	80551.601	1464.8968	38.2727
1/4	135.8742	1870.562	80901.828	1469.1397	38.3281
5/16	136.0705	1875.972	81253.063	1473.3839	38.3835
3/8	136.2669	1881.390	81605.317	1477.6342	38.4389
7/16	136.4632	1886.816	81958.587	1481.9006	38.4943
1/2	136.6596	1892.25	82312.875	1486.1731	38.5497
9/16	136.8559	1897.691	82668.181	1490.4468	38.6050
5/8	137.0523	1903.140	83024.508	1494.7266	38.6604
11/16	137.2486	1908.597	83382.857	1499.0126	38.7158
3/4	137.4450	1914.062	83740.234	1503.3046	38.7712
13/16	137.6413	1919.535	84099.631	1507.6029	38.8266
7/8	137.8377	1925.015	84460.059	1511.9072	38.8820
15/16	138.0340	1930.503	84831.515	1516.2178	38.9374
44 *in.*	138.2304	1936	85184	1520.5344	38.9928
1/16	138.4267	1941.503	85547.515	1524.8572	39.0481
1/8	138.6231	1947.015	85912.063	1529.1860	39.1035
3/16	138.8194	1952.535	86278.844	1533.5211	39.1589
1/4	139.0158	1958.062	86644.265	1537.8622	39.2143
5/16	139.2121	1963.597	87011.918	1542.2046	39.2697
3/8	139.4085	1969.140	87380.614	1546.5530	39.3251
7/16	139.6048	1974.691	87740.259	1550.9176	39.3805
1/2	139.8012	1980.25	88121.125	1555.2883	39.4359
9/16	139.9975	1985.816	88492.943	1559.6602	39.4912
5/8	140.1939	1991.390	88865.805	1564.0382	39.5466
11/16	140.3902	1996.972	89239.713	1568.4223	39.6020
3/4	140.5866	2002.562	89614.652	1572.8125	39.6574
13/16	140.7829	2008.160	89990.674	1577.2090	39.7128
7/8	140.9793	2013.765	90367.731	1581.6115	39.7682
15/16	141.1756	2019.378	90745.839	1586.0203	39.8236

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
45 in.	141.3720	2025	91125	1590.4350	39.8790
1/16	141.5683	2030.628	91515.214	1594.4560	39.9343
1/8	141.7647	2036.265	91886.485	1599.2830	39.9897
3/16	141.9610	2041.910	92268.812	1603.7162	40.0451
1/4	142.1574	2047.562	92652.203	1608.1555	40.1005
5/16	142.3537	2053.222	93036.640	1612.5961	40.1559
3/8	142.5501	2058.890	93422.161	1617.0427	40.2113
7/16	142.7464	2064.566	93808.735	1621.5055	40.2667
1/2	142.9428	2070.25	94196.375	1625.9743	40.3221
9/16	143.1391	2075.941	94585.080	1630.4444	40.3774
5/8	143.3355	2081.640	94974.852	1634.9205	40.4328
11/16	143.5318	2087.347	95363.694	1639.4028	40.4882
3/4	143.7282	2093.062	95757.609	1643.8912	40.5436
13/16	143.9245	2098.735	96149.592	1648.3858	40.5990
7/8	144.1209	2104.515	96544.653	1652.8865	40.6544
15/16	144.3172	2110.253	97239.788	1657.3934	40.7098
46 in.	144.5136	2116	97336	1661.9064	40.7652
1/16	144.7099	2121.753	97733.289	1666.4255	40.8025
1/8	144.9063	2127.515	98131.657	1670.9507	40.8759
3/16	145.1026	2133.285	98231.103	1675.4821	40.9313
1/4	145.2990	2139.062	98931.640	1680.0196	40.9867
5/16	145.4953	2144.847	99333.254	1684.5583	41.0421
3/8	145.6917	2150.640	99735.957	1689.1031	41.0975
7/16	145.8880	2156 441	100139.447	1693.6641	41.1529
1/2	146.0844	2162.25	100544.625	1698.2311	41.2083
9/16	146.2807	2168.066	100950.601	1702.7994	41.2636
5/8	146.4771	2173.890	101357.649	1707.3737	41.3190
11/16	146.6734	2179.722	101765.778	1711.9542	41.3744
3/4	146.8698	2185.562	102175.046	1716.5407	41.4298
13/16	147.0661	2191.410	102185.385	1721.1335	41.4852
7/8	147.2625	2197.265	102996.825	1725.7324	41.5406
15/16	147.4588	2203.128	103413.900	1730.3375	41.5960
47 in.	147.6552	2209	103823	1734.9486	41.6514
1/16	147.8515	2214.878	104237.738	1739.5659	41.7067
1/8	148.0479	2220.765	104653.579	1744.1893	41.7621
3/16	148.2442	2226.660	105070.523	1748.8189	41.8175
1/4	148.4406	2232.562	105488.578	1753.4545	41.8729
5/16	148.6369	2238.472	105907.734	1758.0914	41.9283
3/8	148.8333	2244.390	106328.004	1762.7344	41.9837
7/16	149.0296	2250.316	106749.384	1767.3935	42.0391
1/2	149.2260	2256.25	107171.875	1772.0587	42.0945
9/16	149.4223	2262.191	107593.478	1776.7251	42.1498
5/8	149.6187	2268.140	108020.196	1781.3976	42.2052
11/16	149.8150	2274.097	108446.029	1786.0763	42.2606
3/4	150.0114	2280.062	108872.984	1790.7610	42.3160
13/16	150.2077	2286.035	109310.753	1795.4520	42.3714
7/8	150.4041	2292.015	109730.246	1800.1490	42.4268
15/16	150.6004	2298.003	110160.561	1804.8523	42.4822

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of =square.
48 *in.*	150.7968	2304	110592	1809.5616	42.5376
1/16	150.9931	2310.004	111024.610	1814.2551	42.5929
1/8	151.1895	2316.015	111458.250	1818.9986	42.6483
3/16	151.3858	2322.035	111993.066	1823.7264	42.7037
1/4	151.5822	2328.062	112329.015	1828.4602	42.7591
5/16	151.7785	2334.097	112855.090	1833.1953	42.8145
3/8	151.9749	2340.140	113204.301	1837.9364	42.8699
7/16	152.1712	2346.191	113643.645	1842.6937	42.9253
1/2	152.3676	2352.25	114084.125	1847.4571	42.9807
9/16	152.5639	2358.316	114725.740	1852.2167	43.0361
5/8	152.7603	2364.390	114968.493	1856.9924	43.0915
11/16	152.9566	2370.472	115412.384	1861.7892	43.1468
3/4	153.1530	2376.562	115857.421	1868.5521	43.2022
13/16	153.3493	2382.660	116303.596	1871.3413	43.2576
7/8	153.5457	2388.765	116750.918	1876.1365	43.3130
15/16	153.7420	2394.878	117199.386	1880.9379	43.3684
49 *in.*	153.9384	2401	117649	1885.7454	43.4238
1/16	154.1347	2407.129	118099.810	1890.5591	43.4791
1/8	154.3311	2413.265	118551.672	1895.3788	43.5345
3/16	154.5274	2419.410	119004.734	1900.2047	43.5899
1/4	154.7238	2425.562	119458.953	1905.0367	43.6453
5/16	154.9201	2431.722	119914.320	1909.8700	43.7007
3/8	155.1165	2437.890	120370.848	1914.7093	43.7561
7/16	155.3128	2444.066	120828.532	1919.5648	43.8115
1/2	155.5092	2450.25	121287.375	1924.4263	43.8669
9/16	155.7055	2456.441	121747.376	1929.2891	43.9223
5/8	155.9019	2462.640	122208.539	1934.1579	43.9777
11/16	156.0982	2468.847	122671.264	1939.0329	44.0330
3/4	156.2946	2475.062	123134.359	1943.9140	44.0884
13/16	156.4909	2481.285	123599.014	1948.8013	44.1438
7/8	156.6873	2487.515	124064.336	1953.6947	44.1992
15/16	156.8836	2493.753	124531.835	1958.0943	44.2546
50 *in.*	157.0800	2500	125000	1963.5600	44.3100
1/16	157.2763	2506.254	125469.386	1968.4118	44.3653
1/8	157.4727	2512.515	125939.844	1973.3297	44.4207
3/16	157.6690	2518.785	126411.527	1978.2525	44.4761
1/4	157.8654	2525.062	126884.390	1983.1840	44.5315
5/16	158.0617	2531.347	127358.426	1988.6154	44.5869
3/8	158.2581	2537.640	127833.645	1993.0529	44.6423
7/16	158.4544	2543.941	128310.004	1998.0066	44.6977
1/2	158.6508	2550.25	128787.625	2002.9663	44.7531
9/16	158.8471	2556.566	129266.388	2007.9273	44.8085
5/8	159.0435	2562.890	129746.336	2012.8943	44.8639
11/16	159.2398	2569.222	130327.469	2017.8675	44.9192
3/4	159.4362	2575.562	130709.797	2022.8467	44.9746
13/16	159.6325	2581.910	131193.306	2027.8172	45.0300
7/8	159.8289	2588.265	131678.012	2032.8238	45.0854
15/16	160.0252	2594.628	132163.909	2037.8216	45.1408

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
51 *in.*	160.2216	2601	132651	2042.8254	45.1962
1/16	160.4179	2607.379	133139.336	2047.8354	45.2515
1/8	160.6143	2613.765	133628.766	2052.8515	45.3069
3/16	160.8106	2620.160	134119.445	2057.8798	45.3623
1/4	161.0070	2626.562	134611.328	2062.9021	45.4177
5/16	161.2033	2632.972	135104.406	2067.9317	45.4731
3/8	161.3997	2639.390	135598.692	2072.9674	45.5285
7/16	161.5960	2645.816	136094.121	2078.0293	45.5839
1/2	161.7924	2652.25	136590.875	2083.0771	45.6393
9/16	161.9887	2658.691	137088.775	2088.1362	45.6947
5/8	162.1851	2665.140	137587.883	2093.2014	45.7501
11/16	162.3814	2671.597	138088.220	2098.2678	45.8054
3/4	162.5778	2678.062	138589.734	2103.3502	45.8608
13/16	162.7741	2684.535	139092.474	2108.4339	45.9162
7/8	162.9705	2691.015	139596.434	2113.5236	45.9716
15/16	163.1668	2697.503	140101.557	2118.1196	46.0270
52 *in.*	163.3632	2704	140608	2123.7216	46.0824
1/16	163.5595	2710.504	141115.661	2128.8298	46.1377
1/8	163.7559	2717.015	141624.438	2133.9440	46.1931
3/16	163.9522	2723.535	142134.389	2139.0645	46.2485
1/4	164.1486	2730.062	142645.765	2144.1910	46.3039
5/16	164.3449	2736.597	143158.251	2149.3238	46.3593
3/8	164.5413	2743.140	143671.989	2154.4626	46.4147
7/16	164.7376	2749.691	144186.942	2159.6076	46.4701
1/2	164.9340	2756.25	144703.125	2164.7587	46.5255
9/16	165.1303	2762.816	145219.537	2169.9160	46.5809
5/8	165.3267	2769.390	145739.180	2175.0794	46.6363
11/16	165.5230	2775.972	146606.052	2180.2489	46.6916
3/4	165.7194	2782.562	146780.172	2185.4245	46.7470
13/16	165.9157	2789.160	146953.872	2190.6064	46.8024
7/8	166.1121	2795.765	147826.106	2195.7943	46.8578
15/16	166.3084	2802.378	148350.893	2200.9884	46.9132
53 *in.*	166.5048	2809	148877	2206.1886	46.9686
1/16	166.7011	2815.629	149404.361	2211.3950	47.0239
1/8	166.8975	2822.265	149932.860	2216.6074	47.0793
3/16	167.0938	2828.910	150462.655	2221.8260	47.1347
1/4	167.2902	2835.562	150993.703	2227.0507	47.1901
5/16	167.4865	2842.222	151525.992	2232.2817	47.2455
3/8	167.6829	2848.890	152059.535	2237.5187	47.3009
7/16	167.8792	2855.566	152594.329	2242.7619	47.3563
1/2	168.0756	2862.25	153130.375	2248.0111	47.4117
9/16	168.2719	2868.941	153667.673	2253.2666	47.4671
5/8	168.4683	2875.640	154206.227	2258.5281	47.5225
11/16	168.6646	2882.347	154746.036	2263.7908	47.5778
3/4	168.8610	2889.062	155287.109	2269.0696	47.6332
13/16	169.0573	2895.785	155829.336	2274.3496	47.6886
7/8	169.2537	2902.515	156373.028	2279.6357	47.7440
15/16	169.4500	2909.253	156917.882	2284.9280	47.7994

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of square.
54 in.	169.6464	2916	157464	2290.2264	47.8548
1/16	169.8427	2922.754	158011.436	2295.5309	47.9101
1/8	170.0391	2929.515	158560.032	2300.8415	47.9655
3/16	170.2354	2936.285	159109.948	2306.1583	48.0209
1/4	170.4318	2943.062	159661.140	2311.4812	48.0763
5/16	170.6281	2949.847	160213.597	2316.8163	48.1317
3/8	170.8245	2956.640	160767.332	2322.1455	48.1871
7/16	171.0208	2963.441	161322.541	2327.4819	48.2425
1/2	171.2172	2970.25	161878.625	2332.8343	48.2979
9/16	171.4135	2977.066	162436.185	2338.1880	48.3533
5/8	171.6099	2983.890	162995.024	2343.5477	48.4087
11/16	171.8062	2990.722	163854.242	2348.9636	48.4640
3/4	172.0026	2997.562	164116.547	2354.2855	48.5194
13/16	172.1989	3004.410	164679.328	2359.6637	48.5748
7/8	172.3953	3011.265	165243.199	2365.0480	48.6302
15/16	172.5916	3018.128	165808.456	2370.4385	48.6856
55 in.	172.7880	3025	166375	2375.8350	48.7410
1/16	172.9843	3031.879	166942.886	2381.2382	48.7963
1/8	173.1807	3038.765	167511.953	2386.6465	48.8517
3/16	173.3770	3045.660	168295.866	2392.0515	48.9071
1/4	173.5734	3052.562	168654.078	2397.4825	48.9625
5/16	173.7697	3059.472	169225.578	2402.9098	49.0179
3/8	173.9661	3066.390	169801.379	2408.3432	49.0733
7/16	174.1624	3073.316	170169.779	2413.7777	49.1287
1/2	174.3588	3080.25	170953.875	2419.2283	49.1841
9/16	174.5551	3087.191	171532.072	2424.7026	49.2395
5/8	174.7515	3094.140	172111.570	2430.1830	49.2949
11/16	174.9478	3101.097	172692.372	2435.6246	49.3502
3/4	175.1442	3108.062	173274.484	2441.0722	49.4056
13/16	175.3405	3115.035	173856.496	2446.5486	49.4610
7/8	175.5369	3122.015	174442.621	2452.0310	49.5164
15/16	175.7332	3129.003	175028.655	2457.0197	49.5718
56 in.	175.9296	3136.	175616	2463.0144	49.6272
1/16	176.1259	3143.004	176204.712	2468.5153	49.6825
1/8	176.3223	3150.015	176794.625	2474.0222	49.7379
3/16	176.5186	3157.035	177385.909	2479.5354	49.7933
1/4	176.7150	3164.062	177978.515	2485.0546	49.8487
5/16	176.9113	3171.097	178572.433	2490.5351	49.9041
3/8	177.1077	3178.140	179167.676	2496.1116	49.9595
7/16	177.3040	3185.191	179764.239	2501.6493	50.0149
1/2	177.5004	3192.25	180362.125	2507.1931	50.0703
9/16	177.6967	3199.316	180961.343	2512.7431	50.1257
5/8	177.8931	3206.390	181561.867	2518.2992	50.1811
11/16	178.0894	3213.472	182163.728	2523.8614	50.2364
3/4	178.2858	3220.562	182766.921	2529.4297	50.2918
13/16	178.4821	3227.660	183371.441	2535.0043	50.3472
7/8	178.6785	3234.765	183977.293	2540.5849	50.4026
15/16	178.8748	3241.878	184384.489	2546.1717	50.4580

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
57 in.	179.0712	3249	185193	2551.7646	50.5134
1/16	179.2675	3256.129	185802.912	2557.3637	50.5687
1/8	179.4639	3263.265	186414.047	2562.9688	50.6241
3/16	179.6602	3270.410	187026.577	2568.5801	50.6795
1/4	179.8566	3277.562	187640.453	2574.1975	50.7349
5/16	180.0529	3284.722	188255.664	2579.8212	50.7903
3/8	180.2493	3291.890	188872.223	2585.4509	50.8457
7/16	180.4456	3299.066	189490.126	2591.0869	50.9011
1/2	180.6420	3306.25	190109.375	2596.7287	50.9565
9/16	180.8383	3313.441	190729.970	2602.3769	51.0119
5/8	181.0347	3320.640	191351.914	2608.0311	51.0673
11/16	181.2310	3327.847	191985.008	2613.6942	51.1226
3/4	181.4274	3335.062	192599.859	2619.3580	51.1780
13/16	181.6237	3342.285	193225.857	2625.0307	51.2334
7/8	181.8201	3349.515	193853.215	2630.7095	51.2888
15/16	182.0164	3356.753	194471.829	2636.3945	51.3442
58 in.	182.2128	3364	195112	2642.0856	51.3996
1/16	182.4091	3371.254	195743.487	2647.7328	51.4549
1/8	182.6055	3378.515	196376.219	2653.4861	51.5103
3/16	182.8018	3385.785	197010.370	2659.9565	51.5657
1/4	182.9982	3393.062	197645.890	2664.9112	51.6211
5/16	183.1945	3400.347	198282.869	2670.6330	51.6765
3/8	183 3909	3407.640	198921.020	2676.3609	51.7319
7/16	183.5872	3414.941	199561.638	2682.0950	51.7873
1/2	183.7836	3422.25	200201.625	2687.8351	51.8427
9/16	183.9799	3429.566	200743.982	2693.5814	51.8981
5/8	184.1763	3436.890	201487.711	2699.3338	51.9535
11/16	184.3726	3444.222	202132.813	2705.0924	52.0088
3/4	184.5690	3451.562	202779.296	2710.8571	52.0642
13/16	184.7653	3458.910	203027.158	2716.6280	52.1196
7/8	184.9617	3466.265	204076.387	2722.4050	52.1750
15/16	185.1580	3473.628	204729.005	2726.1882	52.2304
59 in.	185.3544	3481	205379	2733.9774	52.2858
1/16	185.5507	3488.379	206032.437	2739.7728	52.3411
1/8	185.7471	3495.765	206687.141	2745.5743	52.3965
3/16	185.9434	3503.160	207343.288	2751.8820	52.4519
1/4	186.1398	3510.562	208000.828	2757.1957	52.5073
5/16	186.3361	3517.972	208659.649	2763.0157	52.5627
3/8	186.5325	3525.390	209320.066	2768.8418	52.6181
7/16	186.7288	3532.816	209981.374	2774.6745	52.6735
1/2	186.9252	3540.25	210644.875	2780.5123	52.7289
9/16	187.1215	3547.691	211309.369	2786.3568	52.7843
5/8	187.3179	3555.140	212975.258	2792.2074	52.8397
11/16	187.5142	3562.597	212642.544	2798.0642	52.8950
3/4	187.7106	3570.062	213311.234	2803.9270	52.9504
13/16	187.9069	3577.535	213981.318	2809.7461	53.0058
7/8	188.1033	3585.015	214642.809	2815.6712	53.0612
15/16	188.2996	3592.503	215325.702	2821.5526	53.1166

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
60 *in.*	188.4960	3600	216000	2827.4400	53.1720
1/16	188.6923	3607.503	216676.003	2833.3336	53.2274
1/8	188.3887	3615.015	217352.813	2839.2332	53.2828
3/16	189.0850	3622.535	218041.381	2845.1391	53.3381
1/4	189.2814	3630.062	218711.265	2851.0510	53.3935
5/16	189.4777	3637.597	219392.605	2856.9692	53.4489
3/8	189.6741	3645.140	220075.363	2862.8934	53.5043
7/16	189.8704	3652.691	221759.536	2868.8223	53.5597
1/2	189.0668	3660.25	221445.125	2874.7603	53.6151
9/16	190.2631	3667.816	222132.140	2880.7030	53.6705
5/8	190.4595	3675.390	222820.555	2886.6517	53.7259
11/16	190.6558	3682.972	223510.400	2892.6067	53.7813
3/4	190.8522	3690.562	224201.672	2898.5677	53.8367
13/16	191.0485	3698.160	224894.361	2904.5350	53.8920
7/8	191.2449	3705.765	225588.481	2910.5083	53.9474
15/16	191.4412	3713.378	226284.016	2916.4878	54.0028
61 *in.*	191.6376	3721	226981	2922.4734	54.0582
1/16	191.8339	3728.628	227679.402	2928.4652	54.1136
1/8	192.0303	3736.265	228379.235	2934.4630	54.1680
3/16	192.2266	3743.910	229079.699	2940.4670	54.2243
1/4	192.4230	3751.562	229783.203	2946.4771	54.2797
5/16	192.6193	3759.222	230487.336	2952.4938	54.3351
3/8	192.8157	3766.890	231192.911	2958.5159	54.3905
7/16	193.0120	3774.566	231949.923	2964.5445	54.4459
1/2	193.2084	3782.25	232608.375	2970.5791	54.5013
9/16	193.4047	3789.941	233311.067	2976.6200	54.5567
5/8	193.6011	3797.640	234029.602	2982.6669	54.6121
11/16	193.7974	3805.347	234744.380	2988.7200	54.6675
3/4	193.9938	3813.062	235456.609	2994.7792	54.7229
13/16	194.1901	3820.785	236172.279	3000.8423	54.7782
7/8	194.3865	3828.515	236889.403	3006.9161	54.8336
15/16	194.5828	3836.258	237607.976	3017.9938	54.8890
62 *in.*	194.7792	3844	238328	3019.0776	54.9444
1/16	194.9755	3851.753	239050.476	3025.1675	54.9998
1/8	195.1719	3859.515	239772.406	3031.2635	55.0552
3/16	195.3682	3867.285	240496.792	3037.3607	55.1105
1/4	195.5646	3875.062	241222.640	3043.4740	55.1659
5/16	195.7609	3882.847	241948.941	3049.6885	55.2213
3/8	195.9573	3890.640	242678.707	3055.7091	55.2767
7/16	196.1536	3898.441	243408.935	3061.8359	55.3321
1/2	196.3500	3906.25	244140.625	3067.9687	55.3875
9/16	196.5463	3914.066	244873.779	3074.1578	55.4429
5/8	196.7427	3921.890	245608.399	3080.2529	55.4983
11/16	196.9390	3929.722	246344.485	3086.4042	55.5536
3/4	197.1354	3937.562	247082.047	3092.5615	55.6090
13/16	197.3317	3945.410	247821.072	3098.7251	55.6644
7/8	197.5281	3953.265	248561.574	3104·8948	55.7198
15/16	197.7244	3961.128	249309.650	3111·0707	55.7752

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
63 *in.*	197.9208	3969	250047	3117.2526	55.8306
1/16	198.1171	3976.878	250791.925	3124.4407	55.8850
1/8	198.3135	3984.765	251538.328	3129.6349	55.9414
3/16	198.5098	3992.660	252286.210	3135.8353	55.9967
1/4	198.7062	4000.562	253035.578	3142.0417	56.0521
5/16	198.9025	4008.472	253786.921	3148.7544	56.1075
3/8	199.0989	4016.390	254538.754	3154.4732	56.1629
7/16	199.2952	4024.316	255292.571	3160.7981	56.2183
1/2	199.4916	4032.25	256047.875	3166.9291	56.2737
9/16	199.6879	4040.191	256804.665	3173.1663	56.3291
5/8	199.8843	4048.140	257562.945	3179.4096	56.3845
11/16	200.0806	4056.097	258322.715	3185.6591	56.4398
3/4	200.2770	4064.062	259083.984	3191.9146	56.4952
13/16	200.4733	4072.035	259856.739	3193.1764	56.5506
7/8	200.6697	4080.015	260610.996	3204.4442	56.6060
15/16	200.8660	4088.003	261376.749	3210.7183	56.6614
64 *in.*	201.0624	4096	262144	3216.9984	56.7168
1/16	201.2587	4104.003	262912.749	3223.2847	56.7721
1/8	201.4551	4112.015	263683.000	3229.5770	56 8276
3/16	201.6514	4120.035	264454.153	3235.8746	56.8829
1/4	201.8478	4128.062	265228.015	3242.1782	56.9383
5/16	202.0441	4136.097	266102.777	3248.4936	56.9937
3/8	202.2405	4144.140	266779.051	3254.8080	57.0491
7/16	202.4368	4152.191	267557.633	3261.1311	57.1045
1/2	202.6332	4160.25	268336.125	3267.4603	57.1599
9/16	202.8295	4168.316	269054.927	3273.7957	57.2153
5/8	203.0259	4176.390	269899.242	3280.1372	57.2707
11/16	203.2222	4184.472	270683.071	3286.4875	57.3261
3/4	203.4186	4192.562	271468.422	3292.8385	57.3815
13/16	203.6149	4200.650	272248.153	3299.1985	57.4368
7/8	203.8113	4208.765	273043.668	3305.5645	57.4922
15/16	204.0076	4216.878	273814.092	3311.9367	57.5476
65 *in.*	204.2040	4225	274625	3318.3151	57.6030
1/16	204.4003	4233.128	275417.949	3324.7495	57.6584
1/8	204.5917	4241.265	276212.422	3331.0900	57.7138
3/16	204.7930	4249.410	277198.283	3337.9857	57.7691
1/4	204.9894	4257.562	277805.953	3343.8875	57.8245
5/16	205.1857	4265.722	278606.007	3350.2976	57.8799
3/8	205.3821	4273.890	279405.608	3356.7137	57.9353
7/16	205.5784	4282.066	280207.720	3363.1350	57.9907
1/2	205.7748	4290.25	281011.375	3369.5623	58.0461
9/16	205.9711	4298.441	281816.564	3375.9959	58.1015
5/8	206.1675	4306.640	282623.289	3382.4355	58.1569
11/16	206.3638	4314.847	283431.551	3388.8813	58.2122
3/4	206.5602	4323.062	284241.359	3395.3332	58.2676
13/16	206.7565	4331.275	285037.242	3401.7913	58.3230
7/8	206.9529	4339.515	285865.590	3408.2555	58.3784
15/16	207.1492	4347.753	286879.943	3414.7259	58.4338

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
66 *in.*	207.3456	4356	287496	3421.2024	58.4892
1/16	207.5419	4364.253	288313.523	3427.6850	58.5446
1/8	207.7383	4372.515	289132.594	3434.1737	58.5990
3/16	207.9346	4380.785	289953.213	3440.6676	58.6553
1/4	208.1310	4389.062	290775.390	3447.1676	58.7108
5/16	208.3273	4397.347	291592.211	3453.6758	58.7661
3/8	208.5237	4405.640	292424.395	3468.1901	58.8215
7/16	208.7200	4413.941	293251.231	3470.7096	58.8769
1/2	208.9164	4422.25	294079.625	3473.2351	58.9323
9/16	209.1127	4430.566	294899.576	3479.7669	58.9877
5/8	209.3091	4438.890	295741.086	3486.3047	59.0431
11/16	209.5054	4447.222	296574.157	3492.8487	59.0984
3/4	209.7018	4455.562	297408.797	3499.3987	59.1539
13/16	209.8981	4463.900	298744.325	3506.4550	59.2092
7/8	210.0945	4472.265	299082.762	3512.5174	59.2646
15/16	210.2908	4480.628	299922.097	3519.0860	59.3200
67 *in.*	210.4872	4489	300763	3525.6606	59.3754
1/16	210.6835	4497.378	301605.472	3532.2414	59.4308
1/8	210.8799	4505.765	302449.516	3538.8283	59.4862
3/16	211.0762	4514.160	303295.131	3545.4200	59.5415
1/4	211.2726	4522.562	304142.328	3552.0185	59.5969
5/16	211.4689	4530.972	304986.093	3558.6249	59.6523
3/8	211.6653	4539.390	305841.442	3565.2374	59.7077
7/16	211.8616	4547.816	306893.366	3571.8550	59.7631
1/2	212.0580	4556.25	307546.875	3578.4787	59.8185
9/16	212.2543	4564.691	308402.462	3585.1086	59.8739
5/8	212.4507	4573.140	309258.633	3591.7446	59.9293
11/16	212.6470	4581.597	310045.532	3598.8868	59.9847
3/4	212.8434	4590.062	310976.734	3605.0350	60.0401
13/16	213.0397	4598.535	311839.161	3611.6895	60.0954
7/8	213.2361	4607.015	312701.184	3618.3500	60.1508
15/16	213.4324	4615.503	313565.796	3625.0168	60.2062
68 *in.*	213.6288	4624	314432	3631.6896	60.2616
1/16	213.8251	4632.503	315299.796	3638.3686	60.3169
1/8	214.0215	4641.015	316169.187	3645.0536	60.3723
3/16	214.2178	4649.535	317040.174	3651.7439	60.4277
1/4	214.4142	4658.062	317912.766	3658.4402	60.4831
5/16	214.6105	4666.597	318786.948	3665.1448	60.5385
3/8	214.8069	4675.140	319662.738	3671.8554	60.5939
7/16	215.0032	4683.691	320780.130	3678.5762	60.6493
1/2	215.1996	4692.25	321419.125	3685.2931	60.7047
9/16	215.3959	4700.816	322459.724	3692.0212	60.7601
5/8	215.5923	4709.390	323181.930	3698.7554	60.8155
11/16	215.7886	4717.972	324065.743	3703 9957	60.8708
3/4	215.9850	4726.562	324951.172	3712.2421	60.9262
13/16	216.1813	4735.160	325837.204	3718.9948	60.9816
7/8	216.3777	4743.765	326726.977	3725.7535	61.0371
15/16	216.5748	4752.378	327617.120	3732.5184	61.0924

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
69 *in.*	216.7704	4761	328509	3739.2894	61.1478
1/16	216.9667	4769.628	329402.495	3745.8166	61.2032
1/8	217.1631	4778.265	330297.609	3752.8498	61.2586
3/16	217.3594	4786.910	331194.243	3759.6382	61.3139
1/4	217.5558	4795.562	332092.703	3766.4327	61.3693
5/16	217.7521	4804.222	332715.428	3773.2355	61.4247
3/8	217.9485	4812.890	333894.285	3780.0443	61.4801
7/16	218.1448	4821.566	334797.517	3786.8628	61.5355
1/2	218.3412	4830.25	335702.375	3793.6703	61.5909
9/16	218.5375	4838.941	336508.861	3800.5191	61.6463
5/8	218.7339	4847.640	337516.977	3807.3369	61.7017
11/16	218.9302	4856.347	338426.718	3814.2781	61.7571
3/4	219.1266	4865.062	339338.109	3821.0200	61.8125
13/16	219.3229	4873.785	340241.122	3827.8708	61.8678
7/8	219.5193	4882.515	341165.778	3834.7277	61.9233
15/16	219.7156	4891.253	341982.069	3841.5908	61.9786
70 *in.*	219.9120	4900	343000	3848.4600	62.0341
1/16	220.1083	4908.753	343919.570	3855.8353	62.0893
1/8	220.3047	4917.515	344840.781	3862.2167	62.1448
3/16	220.5010	4926.285	345759.635	3869.1033	62.2001
1/4	220.6974	4935.062	346688.141	3875.9960	62.2555
5/16	220.8937	4943.847	347514.284	3882.8969	62.3109
3/8	221.0901	4952.640	348542.082	3889.8039	62.3663
7/16	221.2864	4961.441	349471.528	3896.7211	62.4217
1/2	221.4828	4970.25	350402.625	3903.6343	62.4771
9/16	221.6791	4979.066	351335.372	3910.5538	62.5325
5/8	221.8755	4987.890	352259.774	3917.4093	62.5879
11/16	222.0718	4996.722	353205.828	3924.4260	62.6432
3/4	222.2682	5005.562	354143.547	3931.3607	62.6986
13/16	222.4645	5014.410	355182.915	3938.3177	62.7541
7/8	222.6609	5023.265	356023.949	3945.2728	62.8094
15/16	222.8572	5032.128	356966.643	3952.2341	62.8648
71 *in.*	223.0536	5041	357911	3959.2014	62.9202
1/16	223.2499	5049.878	358857.019	3966.1749	62.9756
1/8	223.4463	5058.765	359804.703	3973.1545	63.0301
3/16	223.6426	5067.660	360754.053	3980.1393	63.0863
1/4	223.8390	5076.562	361705.078	3987.1301	63.1417
5/16	224.0353	5085.472	362657.764	3994.1292	63.1971
3/8	224.2317	5094.390	363612.129	4001.1344	63.2525
7/16	224.4380	5103.316	364568.165	4008.1447	63.3079
1/2	224.6244	5112.25	365525.875	4015.1611	63.3633
9/16	224.8207	5121.191	366485.259	4022.1837	63.4187
5/8	225.0171	5130.140	367446.320	4029.2124	63.4741
11/16	225.2134	5139.097	368409.059	4036.2473	63.5295
3/4	225.4098	5148.062	369373.484	4043.2882	63.5849
13/16	225.6061	5157.035	370339.583	4050.3354	63.6402
7/8	225.8025	5166.015	371307.371	4057.3886	63.6956
15/16	225.9988	5175.003	372276.843	4064.4481	63.7511

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
72 in.	226.1952	5184	373248	4071.5136	63.8064
1/16	226.3915	5193.003	374220.843	4078.5853	63.8617
1/8	226.5879	5202.015	375195.375	4085.6631	63.9171
3/16	226.7842	5211.035	376161.596	4092.7460	63.9725
1/4	226.9806	5220.062	377149.515	4099.8350	64.0279
5/16	227.1769	5229.097	378129.140	4106.9323	64.0833
3/8	227.3733	5238.140	379110.425	4114.0356	64.1367
7/16	227.5696	5247.191	380093.427	4121.1442	64.1941
1/2	227.7660	5256.25	381078.125	4128.2587	64.2495
9/16	227.9623	5265.316	382063.521	4135.3795	64.3049
5/8	228.1587	5274.390	383052.617	4142.5064	64.3603
11/16	228.3550	5283.472	384192.414	4149.6394	64.4157
3/4	228.5514	5292.562	385033.921	4156.7785	64.4711
13/16	228.7477	5301.650	386026.397	4163.9239	64.5264
7/8	228.9441	5310.765	387022.043	4171.0753	64.5818
15/16	229.1404	5319.878	388747.938	4178.2329	64.6372
73 in.	229.3368	5329	389017	4185.3966	64.6926
1/16	229.5331	5338.128	390017.042	4192.5665	64.7470
1/8	229.7295	5347.265	391018.797	4199.7424	64.8034
3/16	229.9258	5356.410	392013.264	4206.9230	64.8587
1/4	230.1222	5365.562	393027.453	4214.1107	64.9141
5/16	230.3185	5374.722	394034.350	4221.3027	64.9695
3/8	230.5149	5383.890	395042.972	4228.5077	65.0249
7/16	230.7112	5393.066	396053.313	4235.7109	65.0803
1/2	230.9076	5402.25	397065.375	4242.9271	65.1357
9/16	231.1039	5411.441	398079.157	4250.1461	65.1911
5/8	231.3003	5420.640	399094.664	4257.3711	65.2465
11/16	231.4966	5429.847	400111.865	4264.6023	65.3018
3/4	231.6930	5439.062	401130.859	4271.8396	65.3572
13/16	231.8893	5448.275	402150.805	4279.0831	65.4126
7/8	232.0857	5457.515	403173.964	4286.3327	65.4650
15/16	232.2820	5466.753	404198.116	4293.5896	65.5234
74 in.	232.4784	5476	405224	4300.8504	65.5788
1/16	232.6747	5485.253	406251.616	4308.1185	65.6341
1/8	232.8711	5494.515	407280.968	4315.3926	65.6895
3/16	233.0674	5503.785	408312.057	4322.1719	65.7449
1/4	233.2638	5513.062	409344.890	4329.9572	65.8003
5/16	233.4601	5522.347	410379.456	4337.2508	65.8557
3/8	233.6565	5531.640	411415.769	4344.5505	65.9111
7/16	233.8528	5540.941	412453.775	4351.8551	65.9665
1/2	234.0492	5550.25	413493.625	4359.1663	66.0219
9/16	234.2455	5559.566	414535.169	4366.4835	66.0773
5/8	234.4419	5568.890	415578.461	4373.8067	66.1327
11/16	234.6382	5578.222	416613.500	4381.1361	66.1880
3/4	234.8346	5587.562	417670.296	4388.4715	66.2434
13/16	235.0309	5596.900	418719.087	4396.8132	66.2988
7/8	235.2273	5606.265	419769.136	4403.1610	66.3542
15/16	235.4236	5615.628	420821.190	4410.5150	66.4096

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
75 *in.*	235.6200	5625	421875	4417.8750	66.4650
1/16	235.8163	5634.378	422930.566	4425.2412	66.5204
1/8	236.0127	5643.765	423987.890	4432.6135	66.5758
3/16	236.2090	5653.160	424046.975	4439.9910	66.6311
1/4	236.4054	5662.562	426107.828	4447.3745	66.6865
5/16	236.6017	5671.972	427170.436	4454.7663	66.7419
3/8	236.7981	5681.390	428234.816	4462.1642	66.7973
7/16	236.9944	5690.816	429300.952	4469.5672	66.8527
1/2	237.1908	5700.25	430368.875	4476.9763	66.9081
9/16	237.3871	5709.691	431438.541	4484.3916	66.9635
5/8	237.5835	5719.140	432510.007	4491.8130	67.0189
11/16	237.7798	5728.597	433583.230	4499.2406	67.0743
3/4	237.9762	5738.062	434658.234	4506.6742	67.1297
13/16	238.1725	5747.525	435734.246	4514.1141	67.1850
7/8	238.3689	5757.015	436813.558	4521.5600	67.2404
15/16	238.5652	5766.503	436893.889	4528.9622	67.2958
76 *in.*	238.7616	5776	438976	4536.4704	67.3512
1/16	238.9579	5785.503	440059.990	4543.9333	67.4066
1/8	239.1543	5795.015	441145.564	4551.4023	67.4610
3/16	239.3506	5804.535	442233.017	4558.8794	67.5173
1/4	239.5470	5814.062	443322.265	4566.3626	67.5727
5/16	239.7433	5823.597	444413.291	4573.8526	67.6281
3/8	239.9397	5833.140	445506.113	4581.3486	67.6835
7/16	240.1360	5842.691	446600.724	4588.8493	67.7289
1/2	240.3324	5852.25	447697.125	4596.3571	67.7943
9/16	240.5287	5861.816	448795.318	4603.8706	67.8497
5/8	240.7251	5871.390	449895.304	4611.3902	67.9051
11/16	240.9214	5880.972	450997.086	4618.9159	67.9605
3/4	241.1178	5890.562	452100.671	4626.4477	68.0159
13/16	241.3141	5900.150	453205.279	4633.9858	68.0712
7/8	241.5105	5909.765	454313.230	4641.5299	68.1266
15/16	241.7068	5919.378	455422.214	4649.0802	68.1821
77 *in.*	241.9032	5929	456533	4656.6366	68.2374
1/16	242.0995	5938.628	457645.589	4664.1992	68.2928
1/8	242.2959	5948.265	458759.984	4671.7678	68.3482
3/16	242.4922	5957.910	459820.610	4679.3416	68.4035
1/4	242.6886	5967.562	460994.203	4686.9215	68.4589
5/16	242.8849	5977.222	462114.022	4694.5097	68.5143
3/8	243.0813	5986.890	463235.660	4702.1039	68.5697
7/16	243.2776	5996.566	464359.110	4709.7033	68.6251
1/2	243.4740	6006.25	465484.375	4717.3087	68.6805
9/16	243.6703	6015.941	466611.474	4724.9204	68.7359
5/8	243.8667	6025.640	467740.351	4732.5381	68.7913
11/16	244.0630	6035.347	468871.166	4740.1620	68.8467
3/4	244.2594	6045.062	470003.609	4747.7920	68.9021
13/16	244.4557	6054.775	471027.187	4755.8782	68.9574
7/8	244.6521	6064.515	472274.152	4763.0705	69.0128
15/16	244.8484	6074.253	473413.963	4771.1690	69.0682

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
78 in.	245.0448	6084	474552	4778.3736	69.1236
1/16	245.2411	6093.753	475693.663	4786.0344	69.1790
1/8	245.4375	6103.515	476837.156	4793.7012	69.2343
3/16	245.6338	6113.285	477982.478	4801.3732	69.2897
1/4	245.8302	6123.062	479129.640	4809.0512	69.3451
5/16	246.0265	6132.847	480277.627	4817.1375	69.4006
3/8	246.2229	6142.640	481429.457	4824.4299	69.4559
7/16	246.4192	6152.441	482582.114	4832.1275	69.5113
1/2	246.6156	6162.25	483736.625	4839.8311	69.5667
9/16	246.8119	6172.066	484752.966	4847.5409	69.6221
5/8	247.0083	6181.890	486051.148	4855.2568	69.6775
11/16	247.2046	6191.722	487211.272	4862.9789	69.7329
3/4	247.4010	6201.562	488373.047	4870.7071	69.7883
13/16	247.5973	6211.400	489736.071	4878.4415	69.8437
7/8	247.7937	6221.265	490702.324	4886.1820	69.6991
15/16	247.9900	6231.128	491769.737	4893.9287	69.9544
79 in.	248.1864	6241	493039.	4901.6814	70.0098
1/16	248.3827	6250.878	494210.113	4909.4403	70.0652
1/8	248.5791	6260.765	495383.078	4917.2053	70.1206
3/16	248.7754	6270.660	496557.896	4924.9755	70.1760
1/4	248.9718	6280.562	497734.578	4932.7517	70.2314
5/16	249.1681	6290.472	498913.108	4940.5362	70.2867
3/8	249.3645	6300.390	500093.504	4948.3268	70.3421
7/16	249.5608	6310.316	501275.757	4956.1225	70.3975
1/2	249.7572	6320.25	502459.875	4963.9243	70.4529
9/16	249.9535	6330.191	503645.853	4971.7319	70.5083
5/8	250.1499	6340.140	504833.695	4979.5456	70.5637
11/16	250.3462	6350.097	506023.401	4987.3663	70.6191
3/4	250.5426	6360.062	507214.992	4995.1930	70.6745
13/16	250.7389	6370.025	508407.621	5003.0316	70.7298
7/8	250.9353	6380.015	509603.746	5010.8642	70.7853
15/16	251.1316	6390.003	510800.936	5018.7091	70.8406
80 in.	251.3280	6400	512000	5026.5600	70.8960
1/16	251.5243	6410.003	513200.937	5034.4171	70.9513
1/8	251.7207	6420.015	514403.750	5042.2803	71.0068
3/16	251.9170	6430.035	515608.439	5050.1486	71.0622
1/4	252.1134	6440.062	516815.016	5058.0230	71.1176
5/16	252.3097	6450.097	518033.463	5065.9027	71.1729
3/8	252.5061	6460.140	519233.801	5073.7944	71.2283
7/16	252.7024	6470.191	520446.020	5081.6883	71.2837
1/2	252.8988	6480.25	521660.125	5089.5883	71.3391
9/16	253.0951	6490.316	522876.114	5097.4941	71.3945
5/8	253.2915	6500.390	524093.992	5105.4060	71.4499
11/16	253.4878	6510.472	525313.758	5113.8248	71.5053
3/4	253.6842	6520.562	526535.422	5121.2497	71.5607
13/16	253.8805	6530.660	527758.969	5129.1855	71.6161
7/8	254.0769	6540.765	528984.418	5137.1173	71.6715
15/16	254.2732	6550.878	530210.761	5145.0603	71.7268

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
81 in.	254.4696	6561	531441	5153.0094	71.7822
1/16	254.6659	6571.128	532672.136	5160.9647	71.8376
1/8	254.8623	6581.265	533903.172	5168.9260	71.8930
3/16	255.0586	6591.410	535140.107	5176.8925	71.9484
1/4	255.2550	6601.562	536376.953	5184.8651	72.0037
5/16	255.4513	6611.722	537615.694	5192.8460	72.0591
3/8	255.6477	6621.890	538856.347	5200.8329	72.1145
7/16	255.8440	6632.066	540098.907	5208.8250	72.1699
1/2	256.0404	6642.25	541343.375	5216.8231	72.2253
9/16	256.2367	6652.441	542589.751	5224.8271	72.2807
5/8	256.4331	6662.640	543838.039	5232.8371	72.3361
11/16	256.6294	6672.847	545088.238	5240.8568	72.3915
3/4	256.8258	6683.062	546340.359	5248.8772	72.4469
13/16	257.0221	6693.285	547594.387	5256.9061	72.5023
7/8	257.2105	6703.515	548850.339	5264.9411	72.5577
15/16	257.4148	6713.753	550108.211	5272.9828	72.6130
82 in.	257.6112	6724	551368	5281.0296	72.6684
1/16	257.8075	6734.253	552629.710	5289.0781	72.7237
1/8	258.0039	6744.515	553863.343	5297.1426	72.7792
3/16	258.2002	6754.785	555158.900	5305.2073	72.8346
1/4	258.3966	6765.062	556426.390	5313.2780	72.8801
5/16	258.5929	6775.347	557695.799	5321.3570	72.9453
3/8	258.7893	6785.640	558967.144	5329.4421	73.0007
7/16	258.9856	6795.941	559140.118	5337.5324	73.0561
1/2	259.1820	6806.25	561515.625	5345.6287	73.1115
9/16	259.3783	6816.566	563292.769	5353.7809	73.1669
5/8	259.5747	6826.890	564071.836	5361.8391	73.2224
11/16	259.7710	6837.222	565352.844	5369.9543	73.2777
3/4	259.9674	6847.562	566635.797	5378.0755	73.3330
13/16	260.1637	6857.910	567900.480	5386.2026	73.3885
7/8	260.3601	6868.265	569207.511	5394.3358	73.4438
15/16	260.5564	6878.628	570496.284	5402.4552	73.4993
83 in.	260.7528	6889	571787	5410.6206	73.5546
1/16	260.9491	6899.378	573079.659	5418.7722	73.6101
1/8	261.1455	6909.765	574374.265	5426.9299	73.6653
3/16	261.3418	6920.160	575670.818	5435.0928	73.7208
1/4	261.5382	6930.562	576969.328	5443.2617	73.7761
5/16	261.7345	6940.972	578269.769	5451.4389	73.8315
3/8	261.9309	6951.390	579572.191	5459.6222	73.8869
7/16	262.1272	6961.816	580876.556	5467.8106	73.9423
1/2	262.3236	6972.25	582182.875	5476.0051	73.9977
9/16	262.5199	6982.691	583491.150	5484.2054	74.0531
5/8	262.7163	6993.140	584801.382	5492.4118	74.1085
11/16	262.9126	7003.597	586113.574	5500.6252	74.1639
3/4	263.1090	7014.062	587427.734	5508.8446	74.2193
13/16	263.3053	7024.535	589067.048	5517.0699	74.2747
7/8	263.5017	7035.015	590061.933	5525.3012	74.3301
15/16	263.6980	7045.503	591381.983	5533.5388	74.3854

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
84 *in.*	263.8944	7056	592704	5541.7824	74.4408
1/16	264.0907	7065.503	593943.922	5550.0322	74.4962
1/8	264.2871	7077.015	595353.937	5558.2881	74.5516
3/16	264.4834	7087.535	596794.862	5566.5491	74.6070
1/4	264.6798	7098.062	598011.765	5574.8162	74.6624
5/16	264.8761	7108.597	599343.635	5583.0916	74.7177
3/8	265.0725	7119.140	600677.488	5591.3730	74.7731
7/16	265.2688	7129.691	602012.317	5599.6596	74.8385
1/2	265.4652	7140.25	603351.125	5607.9523	74.88?9
9/16	265.6615	7150.816	604690.912	5616.2508	74.9393
5/8	265.8579	7161.390	606032.679	5624.5554	74.9947
11/16	266.0542	7171.972	607376.429	5632.8662	75.0601
3/4	266.2506	7182.562	608722.172	5641.1845	75.1055
13/16	266.4469	7193.160	609969.891	5649.5071	75.1608
7/8	266.6433	7203.765	611419.605	5657.8357	75.2162
15/16	266.8396	7214.378	612771.408	5666.1723	75.2716
85 *in.*	267.0360	7225	614125	5674.5150	75.3269
1/16	267.2323	7235.628	615480.693	5682.8630	75.3824
1/8	267.4287	7246.265	616838.359	5691.2170	75.4378
3/16	267.6250	7256.910	618198.029	5699.5762	75.4931
1/4	267.8214	7267.562	619559.703	5707.9415	75.5486
5/16	268.0177	7278.222	620923.365	5716.3151	75.6039
3/8	268.2141	7288.890	622289.035	5724.6947	75.6593
7/16	268.4104	7299.566	623656.713	5733.0795	75.7147
1/2	268.6068	7310.25	625026.375	5741.4703	75.7701
9/16	268.8031	7320.941	626398.048	5749.8670	75.8255
5/8	268.9997	7331.640	627771.726	5758.2697	75.8809
11/16	269.1958	7342.347	629147.409	5766.6794	75.9363
3/4	269.3922	7353.062	630525.109	5775.0952	75.9917
13/16	269.5885	7363.785	631904.808	5783.5168	76.0471
7/8	269.7849	7374.515	633286.527	5791.9445	76.1025
15/16	269.9812	7385.253	634670.257	5800.3784	76.1578
86 *in.*	270.1776	7396	636056	5808.8184	76.2132
1/16	270.3739	7406.753	637443.757	5817.2651	76.2686
1/8	270.5703	7417.515	638833.531	5825.7168	76.3240
3/16	270.7666	7428.285	640325.320	5834.1742	76.3794
1/4	270.9630	7439.062	641619.140	5842.6376	76.4347
5/16	271.1593	7449.847	643014.971	5851.1093	76.4901
3/8	271.3557	7460.640	644412.832	5859.5871	76.5455
7/16	271.5520	7471.441	645812.722	5868.0701	76.6009
1/2	271.7484	7482.25	647214.625	5876.5591	76.6563
9/16	271.9447	7493.066	648078.560	5885.0540	76.7117
5/8	272.1411	7503.890	650024.523	5893.5549	76.7671
11/16	272.3374	7514.722	651432.515	5902.0620	76.8225
3/4	272.5338	7525.562	652842.547	5910.5767	76.8779
13/16	272.7301	7536.410	654254.601	5919.0965	76.9333
7/8	272.9265	7547.265	655668.699	5927.6224	76.9887
15/16	273.1228	7558.128	656984.831	5936.1545	77.0441

[illegible]	[illegible]	[illegible]	[illegible]	Side of square.
			[illegible]	[illegible].922
			[illegible]	[illegible].375
			[illegible]	[illegible].930
			[illegible]	[illegible].444
			[illegible]	[illegible]
			[illegible]	[illegible].531
			[illegible]	[illegible]
			[illegible]	[illegible]
			[illegible]	[illegible]
			[illegible]	[illegible]
			[illegible]	[illegible]

Diameter.	Circum.	Square	Cube	Area	Side of equare.
[illegible]	253.8944	[illegible]	[illegible]	[illegible]	.7580
[illegible]	254.0907	[illegible]	[illegible]	[illegible]	.8134
[illegible]	254.2871	[illegible]	[illegible]	[illegible]	.8688
[illegible]	254.483[illegible]	[illegible]	[illegible]	[illegible]	.9242
[illegible]	254.67[illegible]	[illegible]	[illegible]	[illegible]	.9796
[illegible]	254.87[illegible]	[illegible]	[illegible]	[illegible]	0.0349
[illegible]	255.0[illegible]	[illegible]	[illegible]	[illegible]	.0903
[illegible]	255.2[illegible]	[illegible]	[illegible]	[illegible]	30.1457
[illegible]	255.4[illegible]	[illegible]	[illegible]	[illegible]	30.2011
[illegible]	255.6[illegible]	[illegible]	[illegible]	[illegible]	30.2565
[illegible]	255.8[illegible]	[illegible]	[illegible]	[illegible]	30.3119
[illegible]	256.0[illegible]	[illegible]	[illegible]	[illegible]	30.3673
[illegible]	256.2[illegible]	[illegible]	[illegible]	[illegible]	30.4227
[illegible]	256.4[illegible]	[illegible]	[illegible]	[illegible]	30.4781
[illegible]	256.6[illegible]	[illegible]	[illegible]	[illegible]	30.5335
[illegible]	256.8[illegible]	[illegible]	[illegible]	[illegible]	30.5888
85 inc	257.[illegible]	[illegible]	[illegible]	[illegible]	30.6442
[illegible]	257.[illegible]	[illegible]	[illegible]	[illegible]	30.6996
[illegible]	257.[illegible]	[illegible]	[illegible]	[illegible]	30.7550
[illegible]	257.[illegible]	[illegible]	[illegible]	[illegible]	30.8104
[illegible]	257.[illegible]	[illegible]	[illegible]	[illegible]	30.8658
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	30.9211
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	30.9765
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	31.0319
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	31.0873
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	31.1427
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	31.1981
[illegible]	258.[illegible]	[illegible]	[illegible]	[illegible]	31.2535
[illegible]	259.[illegible]	[illegible]	[illegible]	[illegible]	31.3089
[illegible]	259.[illegible]	[illegible]	[illegible]	[illegible]	31.3643
[illegible]	259.[illegible]	[illegible]	[illegible]	[illegible]	31.4197
[illegible]	259.[illegible]	[illegible]	[illegible]	[illegible]	31.4750
[illegible]	259.[illegible]	[illegible]	[illegible]	[illegible]	31.5304
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.5858
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.6412
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.6966
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.7519
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.8073
[illegible]	260.[illegible]	[illegible]	[illegible]	[illegible]	31.8627
[illegible]	261.[illegible]	[illegible]	[illegible]	[illegible]	31.9181
[illegible]	261.[illegible]	[illegible]	[illegible]	[illegible]	31.9735
[illegible]	261.[illegible]	[illegible]	[illegible]	[illegible]	32.0289
[illegible]	261.[illegible]	[illegible]	[illegible]	[illegible]	32.0843
[illegible]	261.[illegible]	[illegible]	[illegible]	[illegible]	32.1397

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of ⎯ square.
87 *in.*	273.3192	7569	658503	5944.6926	77.0994
1/16	273.5155	7579.878	659913.206	5953.2369	77.1548
1/8	273.7119	7590.765	661345.453	5961.7873	77.2102
3/16	273.9082	7601.660	662769.740	5970.3429	77.2655
1/4	274.1046	7612.562	664196.078	5978.9045	77.3210
5/16	274.3009	7623.472	665618.451	5987.4749	77.3763
3/8	274.4973	7634.390	667054.878	5996.0504	77.4317
7/16	274.6936	7645.316	668487.353	6004.6315	77.4871
1/2	274.8900	7656.25	669921.875	6013.2187	77.5425
9/16	275.0863	7667.191	671368.487	6021.8117	77.5979
5/8	275.2827	7678.140	672797.070	6030.4108	77.6533
11/16	275.4790	7689.097	674237.746	6039.0169	77.7086
3/4	275.6754	7700.062	675680.484	6047.6290	77.7640
13/16	275.8717	7711.035	677125.269	6056.2470	77.8194
7/8	276.0681	7722.015	678572.121	6064.8710	77.8748
15/16	276.2644	7733.003	680021.030	6073.5013	77.9302
88 *in.*	276.4608	7744	681472	6082.1376	77.9856
1/16	276.6671	7755.003	682925.031	6090.7801	78.0409
1/8	276.8535	7766.015	684380.125	6099.4287	78.0964
3/16	277.0498	7777.035	685837.283	6108.0824	78.1518
1/4	277.2462	7788.062	687296.516	6116.7422	78.2071
5/16	277.4425	7799.097	688757.807	6125.4103	78.2625
3/8	277.6389	7810.140	690221.175	6134.0844	78.3179
7/16	277.8352	7821.191	691686.614	6144.2637	78.3733
1/2	278.0316	7832.25	693154.125	6151.4491	78.4287
9/16	278.2279	7843.316	694623.708	6160.1403	78.4841
5/8	278.4243	7854.390	696095.367	6169.8376	78.5395
11/16	278.6206	7865.472	697569.001	6177.5418	78.5949
3/4	278.8170	7876.562	699044.922	6186.2521	78.6503
13/16	279.0133	7887.660	700522.883	6194.9683	78.7057
7/8	279.2097	7898.765	702002.793	6203.6905	78.7610
15/16	279.4060	7909.878	703484.744	6212.4189	78.8164
89 *in.*	279.6024	7921	704969.	6221.1534	78.8718
1/16	279.7987	7932.128	706455.230	6229.8941	78.9272
1/8	279.9951	7943.265	707943.547	6238.6408	78.9826
3/16	280.1914	7954.410	709434.951	6247.3927	79.0379
1/4	280.3878	7965.562	710926.453	6256.1507	79.0934
5/16	280.5841	7976.722	712421.027	6264.9170	79.1487
3/8	280.7805	7987.890	713907.722	6273.6893	79.2041
7/16	280.9768	7999.066	715405.501	6282.4668	79.2595
1/2	281.1732	8010.25	716917.375	6291.2503	79.3149
9/16	281.3695	8021.441	718420.345	6300.0397	79.3703
5/8	281.5659	8032.640	719925.414	6308.8351	79.4258
11/16	281.7622	8043.847	721432.542	6317.6375	79.4811
3/4	281.9586	8055.062	723051.859	6326.4460	79.5364
13/16	282.1549	8066.285	724253.230	6335.2603	79.5919
7/8	282.3513	8077.515	725966.714	6344.0807	79.6473
15/16	282.5476	8088.753	727482.304	6352.9073	79.7026

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
90 *in.*	282.7440	8100	729000	6361.7400	79.7580
1/16	282.9403	8111.253	730519.804	6370.5789	79.8134
1/8	283.1367	8122.515	732041.718	6379.4238	79.8688
3/16	283.3330	8133.785	733565.644	6388.7739	79.9242
1/4	283.5294	8145.062	735091.890	6397.1300	79.9796
5/16	283.7257	8156.347	736619.742	6405.9944	80.0349
3/8	283.9221	8167.640	738150.519	6414.8649	80.0903
7/16	284.1184	8178.941	739683.013	6423.7906	80.1457
1/2	284.3148	8190.25	741217.625	6432.6223	80.2011
9/16	284.5111	8201.566	742754.357	6441.5101	80.2565
5/8	284.7075	8212.890	744293.210	6450.4039	80.3119
11/16	284.9038	8224.222	745824.187	6459.3043	80.3673
3/4	285.1002	8235.562	747377.297	6468.2107	80.4227
13/16	285.2965	8246.910	748522.523	6477.1232	80.4781
7/8	285.4929	8258.265	750469.886	6486.0418	80.5335
15/16	285.6892	8269.628	752019.378	6494.9566	80.5888
91 *in.*	285.8856	8281	753571	6503.8974	80.6442
1/16	286.0819	8292.378	755124.753	6512.8344	80.6996
1/8	286.2783	8303.765	756680.640	6521.7775	80.7550
3/16	286.4746	8315.160	758238.661	6530.7258	80.8104
1/4	286.6710	8326.562	759798.828	6539.6801	80.8658
5/16	286.8673	8337.972	761361.123	6548.6427	80.9211
3/8	287.0637	8349.390	762925.566	6557.6114	80.9765
7/16	287.2600	8360.816	764492.149	6566.5857	81.0319
1/2	287.4564	8372.25	766060.875	6573.5651	81.0873
9/16	287.6527	8383.691	767631.744	6584.5511	81.1427
5/8	287.8491	8395.140	769204.757	6593.5431	81.1981
11/16	288.0454	8406.597	770779.917	6602.5443	81.2535
3/4	288.2418	8418.062	772357.234	6611.5462	81.3089
13/16	288.4381	8429.535	773935.773	6620.5569	81.3643
7/8	288.6345	8441.015	775518.308	6629.5736	81.4197
15/16	288.8388	8452.503	777102.077	6638.5967	81.4750
92 *in.*	289.0272	8464	778688	6647.6258	81.5304
1/16	289.2235	8475.503	780276.077	6656.6609	81.5858
1/8	289.4199	8487.015	781866.312	6665.7021	81.6412
3/16	289.6162	8498.535	783448.704	6674.7485	81.6966
1/4	289.8125	8510.062	785053.265	6683.8010	81.7519
5/16	290.0089	8521.597	786649.978	6692.8618	81.8073
3/8	290.2053	8533.140	788248.863	6701.9286	81.8627
7/16	290.4016	8544.691	789849.911	6711.5001	81.9181
1/2	290.5980	8556.25	791453.125	6720.0787	81.9735
9/16	290.7943	8567.816	793057.505	6729.6628	82.0289
5/8	290.9907	8579.390	794666.054	6738.2530	82.0843
11/16	291.1870	8590.972	796275.773	6747.3497	82.1397
3/4	291.3834	8602.562	797887.672	6756.4525	82.1950
13/16	291.5797	8614.160	799501.734	6765.5614	82.2505
7/8	291.7761	8625.765	801117.980	6774.6763	82.3059
15/16	291.9724	8637.378	802736.411	6783.7975	82.3612

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
93 *in.*	292.1688	8649	804357	6792.9248	82.4166
1/16	292.3651	8660.628	805979.777	6802.0581	82.4720
1/8	292.5615	8672.265	807604.734	6811.1974	82.5274
3/16	292.7578	8683.910	809231.872	6820.3420	82.5828
1/4	292.9542	8695.562	810861.203	6829.4927	82.6382
5/16	293.1505	8707.222	812492.708	6838.6517	82.6935
3/8	293.3469	8718.890	814126.410	6847.8167	82.7489
7/16	293.5432	8730.566	815762.298	6856.9869	82.8043
1/2	293.7396	8742.25	817400.375	6866.1631	82.8597
9/16	293.9359	8753.941	819040.642	6875.3454	82.9151
5/8	294.1323	8765.640	820683.101	6884.5338	82.9705
11/16	294.3286	8777.347	822328.353	6893.7337	83.0259
3/4	294.5350	8789.062	823974.610	6902.9296	83.0813
13/16	294.7213	8800.785	825623.652	6912.1366	83.1367
7/8	294.9177	8812.515	827274.902	6921.3497	83.1921
15/16	295.1140	8824.253	828928.351	6930.5691	83.2475
94 *in.*	295.3104	8836	830584	6939.7946	83.3028
1/16	295.5067	8847.753	832041.851	6949.5261	83.3582
1/8	295.7031	8859.515	833901.906	6958.2636	83.4136
3/16	295.8994	8871.285	835564.165	6968.0064	83.4690
1/4	296.0958	8883.062	837228.640	6976.7552	83.5244
5/16	296.2921	8894.847	838885.214	6986.0123	83.5797
3/8	296.4885	8906.640	840564.207	6995.2755	83.6351
7/16	296.6848	8918.441	842235.209	7004.5439	83.6905
1/2	296.8812	8930.25	843908.625	7013.8183	83.7459
9/16	297.0775	8942.066	845621.988	7023.0988	83.8013
5/8	297.2739	8953.890	847261.898	7032.3853	83.8567
11/16	297.4702	8965.722	848831.858	7041.6784	83.9121
3/4	297.6666	8977.562	850624.047	7050.9775	83.9675
13/16	297.8629	8989.410	852206.445	7060.2827	84.0229
7/8	298.0593	9001.265	853995.074	7069.5940	84.0783
15/16	298.2556	9013.128	856491.925	7075.9116	84.1336
95 *in.*	298.4520	9025	857375	7088.2352	84.1890
1/16	298.6483	9036.878	859068.300	7097.5738	84.2444
1/8	298.8447	9048.765	860763.828	7106.9005	84.2998
3/16	299.0400	9060.660	862461.583	7116.7415	84.3552
1/4	299.2374	9072.562	864161.578	7125.5885	84.4106
5/16	299.4337	9084.472	865863.794	7134.9443	84.4660
3/8	299.6301	9096.390	867568.253	7144.3052	84.5213
7/16	299.8264	9108.316	869274.947	7153.6717	84.5767
1/2	300.0228	9120.25	870983.875	7163.0443	84.6321
9/16	300.2191	9132.191	872695.140	7172.4230	84.6875
5/8	300.4155	9144.140	874408.445	7181.8077	84.7429
11/16	300.6118	9156.097	876124.009	7191.1989	84.7983
3/4	300.8082	9168.062	877841.984	7200.5962	84.8537
13/16	301.0045	9180.035	879566.903	7209.9096	84.9091
7/8	301.2009	9192.015	881284.495	7219.4090	84.9645
15/16	301.3972	9204.003	883009.124	7228.8248	85.0199

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
96 in.	301.5936	9216	884736	7238.2466	85.0752
1/16	301.7899	9228.003	886465.124	7247.6741	85.1306
1/8	301.9863	9248.015	888965.499	7257.1083	85.1860
3/16	302.1826	9252.035	889930.126	7266.5474	85.2414
1/4	302.3790	9264.062	891666.015	7275.9926	85.2967
5/16	302.5753	9276.097	893401.160	7285.4461	85.3521
3/8	302.7717	9288.140	894944.550	7294.9056	85.4075
7/16	302.9680	9300.191	896887.208	7304.3703	85.4629
1/2	303.1644	9312.25	898632.125	7313.8411	85.5183
9/16	303.3607	9324.316	900379.302	7323.3179	85.5737
5/8	303.5571	9336.390	902128.742	7332.8008	85.6291
11/16	303.7534	9348.472	903786.444	7342.2902	85.6845
3/4	303.9498	9360.562	905634.422	7351.7857	85.7399
13/16	304.1461	9372.660	907397.655	7361.2873	85.7952
7/8	304.3425	9384.765	909149.167	7370.7949	85.8506
15/16	304.5388	9396.878	910909.948	7380.3088	85.9060
97 in.	304.7352	9409	912673	7389.8288	85.9614
1/16	304.9315	9421.128	914438.324	7399.3548	86.0167
1/8	305.1279	9433.265	916205.921	7408.8868	86.0722
3/16	305.3242	9445.410	916974.794	7418.6241	86.1276
1/4	305.5206	9457.562	919747.953	7427.9675	86.1830
5/16	305.7169	9469.722	921522.380	7437.5192	86.2383
3/8	305.9133	9481.890	923299.097	7447.0769	86.2937
7/16	306.1096	9494.066	924078.095	7456.6398	86.3491
1/2	306.3060	9506.25	926859.375	7466.2087	86.4045
9/16	306.5023	9518.441	928642.939	7475.7837	86.4599
5/8	306.6987	9530.640	930428.788	7485.3648	86.5153
11/16	306.8950	9542.847	932215.924	7494.9524	86.6570
3/4	307.0914	9555.062	934007.359	7504.5460	86.6626
13/16	307.2877	9567.285	935800.073	7514.1457	86.6814
7/8	307.4841	9579.515	937595.089	7523.7515	86.7368
15/16	307.6804	9591.753	939392.397	7533.3636	86.7922
98 in.	307.8763	9604	941192	7542.9818	86.8476
1/16	308.0731	9616.253	942993.898	7552.6060	86.9030
1/8	308.2695	9628.515	944789.093	7562.2362	86.9584
3/16	308.4658	9640.785	946604.587	7575.8717	87.0138
1/4	308.6622	9653.062	948413.390	7581.5132	87.0692
5/16	308.8585	9665.347	950224.485	7591.1630	87.1245
3/8	309.0549	9677.640	952037.894	7600.8189	87.1799
7/16	309.2512	9689.941	953852.606	7610.4800	87.2353
1/2	309.4476	9702.25	955671.625	7620.1471	87.2907
9/16	309.6439	9714.566	957591.730	7629.8203	87.3461
5/8	309.8403	9726.890	959314.585	7639.4995	87.4015
11/16	310.0366	9739.222	961139.530	7649.1853	87.4569
3/4	310.2330	9751.562	962966.797	7658.8771	87.5123
13/16	310.4293	9763.910	964956.366	7668.5750	87.5677
7/8	310.6257	9776.265	966628.261	7678.2790	87.6231
15/16	310.8220	9788.628	968362.471	7687.9893	87.6785

Dia. or Root.	Circum.	Square.	Cube.	Area.	Side of = square.
99 *in.*	311.0184	9801	970299	7697.7056	87.7338
1/16	311.2147	9813.378	972137.847	7707.4279	87.7892
1/8	311.4111	9825.765	973979.015	7717.1563	87.8446
3/16	311.6074	9838.160	975821.504	7726.8900	87.9001
1/4	311.8038	9850.562	977668.328	7736.6297	87.9554
5/16	312.0001	9862.972	979516.476	7746.3777	88.0107
3/8	312.1965	9875.390	981366.941	7756.1318	88.0661
7/16	312.3928	9887.816	983218.743	7765.8910	88.1215
1/2	312.5892	9900.25	985074.875	7775.6563	88.1769
9/16	312.7855	9912.691	986932.337	7785.4277	88.2323
5/8	312.9819	9925.140	988792.132	7795.2051	88.2877
11/16	313.0782	9937.597	990654.210	7804.9890	88.3431
3/4	313.3746	9950.062	992518.734	7814.7790	88.3985
13/16	313.5709	9962.535	994385.534	7824.5751	88.4539
7/8	313.7673	9975.015	996254.683	7834.3772	88.5093
15/16	313.9636	9987.503	998122.170	7844.1856	88.5646
100 *in.*	314.1600	10000	1000000	7854.0000	88.6200
1/4	314.9454	10050.062	1007518.765	7893.3190	88.8415
1/2	315.7308	10100.25	1015075.125	7932.7360	89.0631
3/4	316.5162	10150.562	1022669.171	7972.2120	89.2847
101 *in.*	317.3016	10201	1030301	8011.8652	89.5062
1/4	318.0870	10251.562	1037970.703	8051.5772	89.7278
1/2	318.8724	10302.25	1045678.37	8091.3870	89.9493
3/4	319.6578	10353.062	1053424.109	8131.2953	90.1709
102 *in.*	320.4432	10404	1061208	8171.3016	90.3924
1/4	321.2286	10455.062	1069030.140	8211.4060	90.6140
1/2	322.0140	10506.25	1076890.625	8251.6084	90.8355
3/4	322.7994	10557.562	1084789.546	8291.8696	91.0571
103 *in.*	323.5848	10609	1092727	8332.3085	91.2786
1/4	324.3702	10660.562	1100703.078	8372.8056	91.5002
1/2	325.1556	10712.25	1108717.875	8413.4008	91.7217
3/4	325.9410	10764.059	1116771.173	8454.0944	91.9433
104 *in.*	326.7264	10816	1124864	8494.8864	92.1648
1/4	327.5118	10868.062	1132995.526	8535.7760	92.3864
1/2	328.2972	10920.25	1141166.125	8576.7640	92.6079
3/4	329.0826	11032.562	1155660.921	8617.8504	92.8295
105 *in.*	329.8680	11025	1157625	8659.0348	93.0510
1/4	330.6534	11077.562	1165913.453	8700.3176	93.2726
1/2	331.4388	11130.25	1174241.375	8741.6980	93.4941
3/4	332.2242	11183.062	1182608.859	8783.1772	93.7157
106 *in.*	333.0096	11236	1191016	8824.7544	93.9372
1/2	334.5804	11342.25	1207949.625	8908.2028	94.3803
107 *in.*	336.1512	11449	1225043	8992.0444	94.8234
1/2	337.7220	11556.25	1242296.875	9076.2784	95.2665
108 *in.*	339.2928	11664	1259712	9160.9056	95.7096
1/2	340.8636	11772.25	1277289.125	9245.9248	96.1527
109 *in.*	342.4344	11881	1295029	9331.3372	96.5958
1/2	344.0052	11990.25	1312932.375	9417.1420	97.0389
110 *in.*	345.5760	12100	1331000	9503.3400	97.4820

A TABLE

CONTAINING

THE CIRCUMFERENCES & AREAS OF CIRCLES,

From 1 *to* 50 *Feet, advancing by an Inch;*

ALSO,

THE SIDE OF A SQUARE OF EQUAL AREA,

AND THE

Content of each in Imperial Gallons and Cubic Yards, at 1 *Foot in depth.*

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of ▭ square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
1 *ft.*	3 1⅛	.7854	0 10⅝	4.8946	.0291
1	3 4⅝	.9217	0 11½	5.7440	.0341
2	3 8	1.0690	1 0⅜	6.6620	.0395
3	3 11	1.2271	1 1¼	7.6472	.0454
4	4 2⅛	1.3962	1 2⅛	8.7011	.0517
5	4 5⅜	1.5761	1 3	9.8222	.0583
6	4 8½	1.7671	1 3⅞	11.0125	.0654
7	4 11⅝	1.9689	1 4¾	12.2701	.0729
8	5 2¾	2.1816	1 5⅝	13.5957	.0808
9	5 5⅞	2.4052	1 6½	14.9892	.0890
10	5 9	2.6398	1 7½	16.4512	.0977
11	6 2¼	2.8852	1 8⅜	17.9025	.1068
2 *ft.*	6 3⅜	3.1416	1 9¼	19.5784	.1163
1	6 6½	3.4087	1 10⅛	21.2430	.1262
2	6 9⅝	3.6869	1 11	22.9767	.1365
3	7 0¾	3.9760	1 11⅞	24.7784	.1472
4	7 3⅞	4.2760	2 0¾	27.2480	.1583
5	7 7	4.5869	2 1⅝	28.5855	.1698
6	7 10¼	4.9087	2 2½	30.5910	.1818
7	8 1⅜	5.2413	2 3⅜	32.6637	.1941
8	8 4½	5.5850	2 4¼	34.8057	.2068
9	8 7⅝	5.9395	2 5¼	37.0149	.2199
10	8 10¾	6.3049	2 6⅛	39.2921	.2335
11	9 1⅞	6.6813	2 7	41.6378	.2474
3 *ft.*	9 5	7.0686	2 7⅞	44.0515	.2618
1	9 8¼	7.4666	2 8¾	46.5318	.2765
2	9 11⅜	7.8757	2 9⅝	49.0813	.2916
3	10 2½	8.2957	2 10¼	51.6988	.3072
4	10 5⅝	8.7265	2 11⅜	54.3835	.3232
5	10 8¾	9.1683	3 0¼	57.0994	.3395
6	10 11⅞	9.6211	3 1⅛	60.9587	.3565
7	11 3	10.0846	3 2	62.8472	.3733
8	11 6⅛	10.5591	3 3	65.8043	.3911
9	11 9⅜	11.0446	3 3⅞	68.8299	.4090
10	12 5½	11.5409	3 4¾	71.9228	.4274
11	12 3⅝	12.0481	3 5⅝	75.0837	.4462
4 *ft.*	12 6¾	12.5664	3 6½	78.3128	.4654
1	12 9⅞	13.0952	3 7⅜	81.6092	.4851
2	13 1	13.6353	3 8¼	84.9751	.5050
3	13 4⅛	14.1862	3 9⅛	85.8583	.5254
4	13 7¼	14.7479	3 10	91.9089	.5462
5	13 10½	15.3206	3 10⅞	95.4779	.5674
6	14 1⅝	15.9043	3 11⅞	99.1155	.5893
7	14 4⅝	16.4986	4 0¾	102.8192	.6111
8	14 7⅞	17.1041	4 1⅝	106.5927	.6334
9	14 11	17.7205	4 2½	110.4341	.6563
10	15 2⅛	18.3476	4 3⅜	114.3421	.6795
11	15 5¼	18.9858	4 4¼	118.3818	.7032

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of — square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
5 *ft.*	15 8⅛	19.6350	4 5⅛	122.3653	.7272
1	15 11⅝	20.2947	4 6	126.4765	.7516
2	16 2⅞	20.9656	4 6⅞	130.6576	.7764
3	16 5¾	21.6475	4 7¾	134.9072	.8017
4	16 9	22.3400	4 8⅝	139.2228	.8275
5	17 0⅛	23.0437	4 9⅝	143.6083	.8534
6	17 3¼	23.7583	4 10⅛	148.0617	.8800
7	17 6⅜	24.4835	4 11⅜	152.5811	.9071
8	17 9⅝	25.2199	5 0¼	157.1704	.9340
9	18 0¾	25.9672	5 1⅜	161.8275	.9617
10	18 3⅞	26.7251	5 2	166.5508	.9897
11	18 7⅛	27.4943	5 2⅞	171.3444	1.0184
6 *ft.*	18 10⅛	28.2744	5 3¾	176.2060	1.0472
1	19 1¼	29.0649	5 4⅝	181.1324	1.0764
2	19 4⅜	29.8668	5 5½	185.1298	1.1042
3	19 7½	30.6796	5 6⅜	191.1952	1.1363
4	19 10⅝	31.5029	5 7⅜	196.3320	1.1667
5	20 1⅞	32.3376	5 8¼	201.5279	1.1976
6	20 4⅞	33.1831	5 9⅛	206.7970	1.2290
7	20 8⅛	34.0391	5 10	212.1376	1.2607
8	20 11½	34.9065	5 10⅞	217.5373	1.2928
9	21 2⅜	35.7847	5 11¾	223.0102	1.3253
10	21 5½	36.6735	6 0⅝	228.4492	1.3582
11	21 8¾	37.5736	6 1½	234.1586	1.3926
7 *ft.*	21 11⅞	38.4846	6 2⅜	239.8360	1.4254
1	22 3	39.4060	6 3¼	245.5781	1.4602
2	22 6⅛	40.3388	6 4⅛	251.3914	1.4940
3	22 9¼	41.2825	6 5⅛	257.2725	1.5300
4	23 0⅜	42.2367	6 6	263.2191	1.5643
5	23 2⅞	43.2022	6 6⅞	269.2361	1.6001
6	23 6¾	44.1787	6 7¾	275.3216	1.6361
7	23 11	45.1656	6 8⅝	281.4720	1.6728
8	24 1⅛	46.1638	6 9½	287.6928	1.7098
9	24 4⅛	47.1730	6 10⅜	293.9721	1.7471
10	24 7¼	48.1926	6 11¼	300.3362	1.7849
11	24 10⅜	49.2236	7 0	306.7614	1.8231
8 *ft.*	25 1½	50.2656	7 0⅛	313.2552	1.8617
1	25 4⅝	51.3178	7 1¾	319.8125	1.9007
2	25 7⅞	52.3816	7 2⅞	326.4421	1.9394
3	25 11	53.4562	7 3¾	333.1390	1.9800
4	26 2⅛	54.5412	7 4⅝	339.9007	2.0201
5	26 5¼	55.6377	7 5½	346.7341	2.0607
6	26 8⅜	56.7451	7 6⅜	353.6354	2.1017
7	26 11½	57.8628	7 7¼	360.6009	2.1430
8	27 2⅝	58.9920	7 8⅛	367.6381	2.1850
9	27 5¾	60.1321	7 9⅛	374.3432	2.2698
10	27 9	61.2826	7 9⅞	381.9031	2.3128
11	28 0⅛	62.4445	7 10¾	389.1541	2.4001

	4.4847
	4.6451
	4.6659
	4.6671
	4.7387
	4.7907
	4.8537

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
13 *ft.*	40 10	132.7326	11 6¼	827.1895	4.9160
1	41 1⅛	134.4391	11 7⅛	837.8244	4.9792
2	41 4⅜	136.1574	11 8⅛	848.5329	5.0428
3	41 7½	137.8867	11 8⅞	859.3099	5.1106
4	41 10⅝	139.6260	11 9¾	870.1492	5.1713
5	42 1⅞	141.3771	11 10⅝	881.0620	5.2361
6	42 4⅛	143.1391	11 11⅝	892.0428	5.3014
7	42 8	144.9111	12 0½	907.0859	5.3670
8	42 11⅛	146.6949	12 1⅜	914.2026	5.4331
9	43 2¼	148.4896	12 2¼	923.3871	5.4996
10	43 5⅛	150.2943	12 3⅛	936.6340	5.5653
11	43 8⅝	152.1109	12 4	947.9551	5.6337
14 *ft.*	43 11⅜	153.9384	12 4⅞	959.3441	5.7014
1	44 2⅜	155.7758	12 5⅝	970.7947	5.7694
2	44 6	157.6250	12 6½	982.3190	5.8369
3	44 9⅛	159.4852	12 7½	993.9117	5.9069
4	45 0¼	161.3553	12 8⅜	1005.5662	5.9761
5	45 3½	163.2373	12 9⅜	1017.2958	6.0458
6	45 6⅝	165.1303	12 10¼	1029.0920	6.1159
7	45 9¾	167.0331	12 11⅛	1040.9502	6.1864
8	46 0⅞	168.9479	13 0	1052.8733	6.2573
9	46 4	170.8735	13 1⅛	1064.8846	6.3286
10	46 7⅛	172.8091	13 1⅞	1076.9462	6.4410
11	46 11¼	174.7565	13 2⅝	1089.0825	6.4724
15 *ft.*	47 1½	176.7150	13 3½	1101.2878	6.5450
1	47 4⅝	178.6832	13 4⅜	1113.4537	6.6178
2	47 7¾	180.6634	13 5¼	1125.8943	6.6912
3	47 10⅞	182.6545	13 6⅛	1138.3028	6.7649
4	48 2½	184.6555	13 7⅛	1149.7730	6.8390
5	48 5⅝	186.6684	13 8	1163.3174	6.9126
6	48 8¼	188.6923	13 8⅞	1172.9304	6.9886
7	48 11⅜	190.7260	13 9¾	1188.6954	7.0639
8	49 2⅝	192.7716	13 10⅝	1201.3626	7.1396
9	49 5¾	194.8282	13 11½	1214.1693	7.2158
10	49 8⅞	196.8946	14 0⅜	1227.0471	7.2923
11	50 0	198.9730	14 1¼	1236.9997	7.3693
16 *ft.*	50 3⅛	201.0624	14 2⅛	1253.0208	7.4467
1	50 6¼	203.1615	14 3	1266.1023	7.5245
2	50 9⅜	205.2726	14 3⅞	1279.2588	7.6026
3	51 0½	207.3946	14 4⅞	1292.4831	7.6812
4	51 3¾	209.5264	14 5¾	1306.7685	7.7602
5	51 6½	211.6703	14 6¾	1319.1293	7.8396
6	51 10	213.8251	14 7½	1332.5580	7.9194
7	52 1⅛	215.9896	14 8⅜	1346.0471	7.9996
8	52 4¼	218.1662	14 9¼	1359.6138	8.0802
9	52 7⅜	220.3537	14 10⅛	1373.2442	
10	52 10½	222.5510	14 11	1386.9378	
11	53 1⅝	224.7603	14 11⅞	1400.7061	

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of — square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
9 *ft.*	28 3¼	63.6174	7 11⅝	396.4636	2.3562
1	28 6⅜	64.8006	8 0½	403.8373	2.4000
2	28 9½	65.9951	8 1½	411.2814	2.4443
3	29 0⅝	67.2007	8 2⅜	418.7947	2.4889
4	29 3¾	68.4166	8 3¼	426.3722	2.5339
5	29 7	69.6440	8 4⅛	434.0214	2.5795
6	29 10⅛	70.8823	8 5	441.7384	2.6263
7	30 1¼	72.1309	8 5⅞	449.5197	2.6715
8	30 4⅜	73.3910	8 6¾	457.3727	2.7183
9	30 7½	74.6620	8 7⅝	465.2935	2.7653
10	30 11⅝	75.9433	8 8½	473.2786	2.8128
11	31 1¾	77.2362	8 9½	481.3359	2.8607
10 *ft.*	31 5	78.5400	8 10¼	489.4612	2.9089
1	31 8⅛	79.8540	8 11¼	497.6501	2.9575
2	31 11¼	81.1795	9 0⅛	505.9106	3.0066
3	32 2⅜	82.5160	9 1	514.2397	3.0561
4	32 5½	83.8627	9 1⅞	522.6323	3.1060
5	32 8⅝	85.2211	9 2¾	530.9978	3.1563
6	32 11¾	86.5903	9 3⅝	539.6307	3.2070
7	33 2⅞	87.9697	9 4½	548.2271	3.2211
8	33 6⅛	89.3608	9 5⅜	556.8965	3.3096
9	33 9¼	90.7627	9 6¼	565.2331	3.3615
10	34 0⅜	92.1749	9 7¼	574.4339	3.4138
11	34 3½	93.5986	9 8⅛	583.3064	3.4665
11 *ft.*	34 6⅝	95.0334	9 8⅞	592.2481	3.5197
1	34 9¾	96.4783	9 9⅞	601.2529	3.5733
2	35 0⅞	97.9347	9 10¾	610.3290	3.6272
3	35 4⅛	99.4021	9 11⅝	619.4738	3.6815
4	35 7¼	100.8797	10 0½	628.6822	3.7362
5	35 10⅝	102.3689	10 1⅜	637.9629	3.7914
6	36 1½	103.8691	10 2¼	647.3122	3.8470
7	36 4½	105.3794	10 3⅛	656.7244	3.9029
8	36 7¾	106.9013	10 4	666.2089	3.9593
9	36 10⅞	108.4342	10 5	675.7619	4.0160
10	37 2¾	109.9772	10 5⅞	685.3779	4.0732
11	37 5¼	111.5319	10 6¾	695.0668	4.1308
12 *ft.*	37 8⅜	113.0976	10 7⅝	706.8242	4.1888
1	37 11½	114.6732	10 8½	714.6433	4.2471
2	38 2⅝	116.2607	10 9⅜	724.5366	4.3059
3	38 5¾	117.8590	10 10¼	734.4972	4.3651
4	38 8⅞	119.4674	10 11⅛	744.5208	4.4241
5	39 0	121.0876	11 0	754.5179	4.4847
6	39 3¼	122.7187	11 0⅞	764.7829	4.5451
7	39 6⅜	124.3598	11 1⅞	775.0102	4.6059
8	39 9½	126.0127	11 2⅝	785.3111	4.6671
9	40 0⅝	127.6765	11 3⅝	795.6799	4.7287
10	40 3¾	129.3504	11 4½	806.1116	4.7907
11	40 6⅞	131.0360	11 5⅜	816.6163	4.8531

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
13 *ft.*	40 10	132.7326	11 6¼	827.1895	4.9160
1	41 1⅛	134.4391	11 7⅛	837.8244	4.9792
2	41 4⅜	136.1574	11 8⅛	848.5329	5.0428
3	41 7⅛	137.8867	11 8⅞	859.3099	5.1106
4	41 10⅝	139.6260	11 9¾	870.1492	5.1713
5	42 1⅝	141.3771	11 10⅝	881.0620	5.2361
6	42 4⅞	143.1391	11 11⅝	892.0428	5.3014
7	42 8	144.9111	12 0½	907.0859	5.3670
8	42 11⅛	146.6949	12 1⅝	914.2026	5.4331
9	43 2¼	148.4896	12 2¼	923.3871	5.4996
10	43 5⅛	150.2943	12 3⅛	936.6340	5.5653
11	43 8⅝	152.1109	12 4	947.9551	5.6337
14 *ft.*	43 11¾	153.9384	12 4⅞	959.3441	5.7014
1	44 2⅞	155.7758	12 5⅝	970.7947	5.7694
2	44 6	157.6250	12 6½	982.3190	5.8369
3	44 9⅛	159.4852	12 7½	993.9117	5.9069
4	45 0¼	161.3553	12 8⅜	1005.5662	5.9761
5	45 3½	163.2373	12 9⅜	1017.2958	6.0458
6	45 6⅝	165.1303	12 10¼	1029.0920	6.1159
7	45 9¾	167.0331	12 11⅛	1040.9502	6.1864
8	46 0⅞	168.9479	13 0	1052.8733	6.2573
9	46 4	170.8735	13 1⅛	1064.8846	6.3286
10	46 7⅛	172.8091	13 1¾	1076.9462	6.4410
11	46 11¼	174.7565	13 2⅝	1089.0825	6.4724
15 *ft.*	47 1½	176.7150	13 3½	1101.2878	6.5450
1	47 4⅝	178.6832	13 4⅜	1113.4537	6.6178
2	47 7¾	180.6634	13 5¼	1125.8943	6.6912
3	47 10⅞	182.6545	13 6⅛	1138.3028	6.7649
4	48 2½	184.6555	13 7⅛	1149.7730	6.8390
5	48 5⅛	186.6684	13 8	1163.3174	6.9126
6	48 8¼	188.6923	13 8⅞	1172.9304	6.9886
7	48 11⅜	190.7260	13 9¾	1188.6054	7.0639
8	49 2⅝	192.7716	13 10⅝	1201.3626	7.1396
9	49 5¾	194.8282	13 11½	1214.1693	7.2158
10	49 8⅞	196.8946	14 0⅜	1227.0471	7.2923
11	50 0	198.9730	14 1¼	1236.9997	7.3693
16 *ft.*	50 3⅛	201.0624	14 2⅛	1253.0208	7.4467
1	50 6¼	203.1615	14 3	1266.1023	7.5245
2	50 9⅝	205.2726	14 3⅞	1279.2588	7.6026
3	51 0½	207.3946	14 4⅞	1292.4831	7.6812
4	51 3¾	209.5264	14 5¾	1306.7685	7.7602
5	51 6½	211.6703	14 6⅝	1319.1293	7.8396
6	51 10	213.8251	14 7½	1332.5580	7.9194
7	52 1⅛	215.9896	14 8⅜	1346.0471	7.9996
8	52 4¼	218.1662	14 9¼	1359.6138	8.0802
9	52 7⅜	220.3537	14 10⅛	1373.2442	8.1612
10	52 10½	222.5510	14 11	1386.9378	8.2426
11	53 1⅝	224.7603	14 11⅞	1400.7061	8.3444

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of — square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
17 *ft.*	53 4⅞	226.9806	15 0¾	1414.5430	8.4067
1	53 8	229.2105	15 1⅛	1428.4398	8.4890
2	53 11⅛	231.4525	15 2⅝	1442.4119	8.5352
3	54 2⅛	233.7055	15 3½	1456.4526	8.6557
4	54 5⅜	235.9682	15 4⅜	1470.5538	8.7395
5	54 8½	238.2430	15 5¼	1484.6303	8.8238
6	54 11⅝	240.5287	15 6⅛	1498.9748	8.9081
7	55 2⅞	242.8241	15 7	1513.2792	8.9234
8	55 6	245.1316	15 7⅞	1527.6601	9.0789
9	55 9⅛	247.4500	15 8¾	1542.1084	9.1648
10	56 0¼	249.7781	15 9⅝	1556.6171	9.2510
11	56 3½	252.1184	15 10½	1571.2018	9.3377
18 *ft.*	56 6½	254.4696	15 11⅜	1585.8545	9.4248
1	56 9⅝	256.8303	16 0⅜	1600.5664	9.5122
2	57 0⅞	259.2033	16 1¼	1615.3549	9.6000
3	57 4	261.5872	16 2⅛	1630.2114	9.6884
4	57 7⅛	263.9807	16 3⅛	1645.1277	9.7252
5	57 10¼	266.3864	16 3⅞	1660.1200	9.8661
6	58 1⅜	268.8031	16 4¾	1675.1809	9.9556
7	58 4½	271.2293	16 5⅝	1690.3009	10.0451
8	58 7⅝	273.6678	16 6½	1705.4977	10.1358
9	58 10¾	276.1171	16 7⅜	1720.7617	10.2264
10	59 2	278.5761	16 8¼	1736.0862	10.3176
11	59 5⅛	281.0472	16 9¼	1751.4861	10.4091
19 *ft.*	59 8¼	283.5294	16 10	1766.9552	10.5011
1	59 11½	286.0210	16 11	1782.4828	10.5933
2	60 2½	288.5249	16 11⅞	1798.0871	10.6861
3	60 5⅝	291.0397	17 0¾	1813.7594	10.7792
4	60 8¾	293.5641	17 1⅝	1829.4914	10.8727
5	60 11⅞	296.1107	17 2½	1845.3005	10.9665
6	61 3⅛	298.6483	17 3⅜	1861.0762	11.0610
7	61 6¼	301.2054	17 4¼	1877.1120	11.1668
8	61 9⅜	303.7747	17 5⅛	1893.1239	11.2509
9	62 0½	306.3550	17 6	1909.2043	11.3464
10	62 3⅝	308.9448	17 7	1925.3439	11.4424
11	62 6¾	311.5469	17 7⅞	1941.5602	11.5384
20 *ft.*	62 9⅞	314.1600	17 8⅝	1957.8451	11.6355
1	63 1⅜	316.7824	17 9⅝	1974.1879	11.7326
2	63 4¼	319.4173	17 10½	1990.6086	11.8302
3	63 7⅝	322.0630	17 11⅜	2007.0966	11.9282
4	63 11½	324.7182	18 0¼	2023.6438	12.0266
5	64 1⅝	327.3858	18 1⅛	2040.2683	12.1254
6	64 4¾	330.0643	18 2	2056.9607	12.2246
7	64 7⅞	332.7522	18 2⅞	2073.7117	12.3241
8	64 11	335.4525	18 3¾	2090.5399	12.4241
9	65 2¼	338.1637	18 4¾	2107.4361	12.5245
10	65 5⅜	340.8844	18 5⅝	2124.3915	12.6253
11	65 8¼	343.6174	18 6½	2141.4236	12.7265

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
21 *ft.*	65 11⅛	346.3614	18 7¼	2158.5242	12.8282
1	66 2¾	349.1147	18 8¼	2175.6828	12.9301
2	66 5⅞	351.8804	18 9⅛	2192.9186	13.0326
3	66 9	354.6571	18 10	2210.2110	13.1354
4	66 0⅛	357.4432	18 10⅞	2227.5860	13.2386
5	67 3⅜	360.2417	18 11¾	2245.0362	13.3422
6	67 6½	363.0511	19 0⅝	2262.5344	13.4463
7	67 9⅝	365.8698	19 1⅝	2280.1004	13.5507
8	68 0¾	368.7011	19 2½	2297.7452	13.6555
9	68 3⅞	371.5432	19 3⅜	2315.4572	13.7608
10	68 7	374.3947	19 4¼	2333.2277	13.8664
11	68 10¼	377.2587	19 5⅛	2351.0762	13.9725
22 *ft.*	69 1⅜	380.1336	19 5⅞	2368.9925	14.0800
1	69 4½	383.0177	19 6⅞	2386.9663	14.1858
2	69 7⅝	385.9144	19 7¾	2405.0185	14.2931
3	69 10¾	388.8220	19 8⅝	2423.1387	14.4008
4	70 1⅞	391.7389	19 9½	2441.3168	14.5088
5	70 5	394.6683	19 10⅜	2458.5728	14.6173
6	70 8¼	397.6087	19 11⅜	2477.9074	14.7262
7	70 11⅛	400.5583	20 0¼	2496.2793	14.8354
8	71 2½	403.5204	20 1⅛	2514.7391	14.9452
9	71 5⅝	406.4935	20 2	2533.2674	15.0558
10	71 8¾	409.4759	20 2⅞	2551.8538	15.1657
11	71 11⅞	412.4707	20 3¾	2570.5174	15.2766
23 *ft.*	72 3	415.4766	20 4½	2589.2501	15.3880
1	72 6⅛	418.4915	20 5½	2607.9390	15.4996
2	72 9⅜	421.5192	20 6⅜	2626.9076	15.6118
3	73 0½	424.5577	20 7¼	2645.8435	15.7243
4	73 3⅝	427.6055	20 8⅛	2664.8374	15.8372
5	73 6¾	430.6658	20 9⅛	2683.9092	15.9505
6	73 9⅞	433.7371	20 10	2703.0496	16.0643
7	74 1	436.8175	20 10⅞	2722.2466	16.1784
8	74 4⅛	439.9106	20 11¾	2741.5228	16.2929
9	74 7¼	443.0146	21 0⅝	2760.8669	16.4079
10	74 10⅝	446.1278	21 1½	2780.2684	16.5232
11	75 1⅝	449.2536	21 2⅜	2799.7484	16.6390
24 *ft.*	75 4¾	452.3904	21 3¼	2819.2969	16.7556
1	75 7⅞	455.5362	21 4⅛	2838.9015	16.8717
2	75 11	458.6948	21 5	2858.5859	16.9886
3	76 2⅛	461.8642	21 6	2878.3376	17.1060
4	76 5¼	465.0428	21 6⅞	2898.1467	17.2608
5	76 8½	468.2341	21 7¾	2918.0349	17.3420
6	76 11⅝	471.4363	21 8⅝	2937.9941	17.4606
7	77 2¾	474.6476	21 9½	2958.0038	17.5795
8	77 5⅞	477.8716	21 10⅜	2978.0958	17.6989
9	77 9	481.1065	21 11¼	2998.2557	17.8187
10	78 0⅛	484.3506	22 0⅛	3018.4729	17.9389
11	78 3¼	487.6073	22 1	3038.8686	18.3019

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
25 *ft.*	78 6⅜	490.8750	22 1⅞	3059.1330	18.1805
1	78 9½	494.1516	22 2¾	3079.5527	18.2385
2	79 0¾	497.4411	22 3¾	3100.0529	18.4237
3	79 3⅞	500.7415	22 4⅝	3120.6210	18.6687
4	79 7⅛	504.0510	22 6½	3141.2458	18.7196
5	79 11⅛	507.3732	22 6⅜	3161.9497	18.7916
6	80 1¼	510.7063	22 7¼	3182.7214	18.9150
7	80 4⅜	514.0484	22 8⅛	3203.5496	19.0388
8	80 7⅝	517.4034	22 9	3224.4579	19.1630
9	80 10¾	520.7692	22 9⅞	3245.4336	19.2877
10	81 1⅞	524.1441	22 10¾	3266.4860	19.4127
11	81 5	527.5318	22 11⅝	3287.6381	19.5382
26 *ft.*	81 8⅛	530.9304	23 0½	3308.7582	19.6640
1	81 11¼	534.3379	23 1½	3329.9937	19.7902
2	82 2⅜	537.7583	23 2⅜	3351.3097	19.9169
3	82 5¼	541.1896	23 3¼	3372.6935	20.0440
4	82 8⅝	544.6299	23 4⅛	3394.1535	20.1714
5	82 11⅞	548.0830	23 5	3415.6532	20.2993
6	83 3	551.5471	23 5⅞	3437.2415	20.4276
7	83 6½	555.0201	23 6¾	3458.8852	20.5562
8	83 9¼	558.5059	23 7⅝	3480.6087	20.6854
9	84 0⅜	562.0027	23 8½	3502.3008	20.8149
10	84 3½	565.5084	23 9⅜	3524.2483	20.9447
11	84 6⅝	569.0270	23 10¼	3546.1762	21.0750
27 *ft.*	84 9⅞	572.5566	23 11⅛	3568.1727	21.2058
1	85 1	576.0949	24 0⅛	3590.2234	21.3368
2	85 4¼	579.6463	24 1	3612.3557	21.4683
3	85 8⅛	583.2085	24 1⅞	3634.5553	21.6003
4	85 11⅜	586.7796	24 2¾	3656.8104	21.7325
5	86 1½	590.3637	24 3⅝	3679.1465	21.8653
6	86 4⅝	593.9587	24 4½	3701.5506	21.9984
7	86 7⅞	597.5625	24 5⅜	3724.0094	22.1319
8	86 11	601.1793	24 6¼	3746.5493	22.2569
9	87 2⅛	604.8070	24 7⅛	3769.1572	22.4002
10	87 5¼	608.4436	24 8⅛	3791.8205	22.5349
11	87 8⅜	612.0931	24 9	3814.5641	22.6701
28 *ft.*	87 11½	615.7536	24 9¾	3837.3764	22.8056
1	88 2⅝	619.4228	24 10¾	3860.2428	22.9415
2	88 5¾	623.1050	24 11½	3883.1903	23.0779
3	88 9	626.7982	25 0½	3905.4063	23.2147
4	89 0⅛	630.5002	25 1⅜	3929.2772	23.3154
5	89 3¼	634.2152	25 2¼	3952.4291	23.4894
6	89 6⅜	637.9411	25 3⅛	3975.6489	23.6274
7	89 9½	641.6758	25 4	3998.9235	23.7457
8	90 0⅝	645.4235	25 4⅞	4022.4662	23.9045
9	90 3¾	649.1821	25 5⅞	4045.7028	24.0437
10	90 6⅞	652.9495	25 6¾	4069.1813	24.1833
11	90 11⅛	656.7300	25 7⅝	4092.3413	24.3249

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
29 *ft.*	91 1¼	660.5214	25 8⅝	4116.3693	24.4637
1	91 4⅜	664.3214	25 9⅜	4140.0509	24.6044
2	91 7½	668.1346	25 10¼	4163.8148	24.7457
3	91 10⅝	671.9587	25 11⅛	4187.6466	24.8873
4	92 1¾	675.7915	26 0	4211.5326	25.0293
5	92 4⅞	679.6375	26 0⅞	4234.4839	25.1717
6	92 8⅛	683.4943	26 1¾	4259.5364	25.2405
7	92 11⅛	687.3598	26 2⅝	4283.6263	25.4577
8	93 2⅜	691.2385	26 3⅝	4308.7983	25.6014
9	93 5½	695.1280	26 4½	4332.0376	25.7454
10	93 8⅝	699.0263	26 5⅜	4356.3319	25.8898
11	93 11⅞	702.9377	26 6¼	4380.7077	26.0347
30 *ft.*	94 2⅞	706.8600	26 7	4405.1515	26.1800
1	94 6	710.7909	26 8	4429.6488	26.3255
2	94 9¼	714.7350	26 8⅞	4454.2285	26.4716
3	95 0⅝	718.6900	26 9¾	4478.8760	26.6181
4	95 3½	722.6537	26 10⅝	4503.5779	26.7649
5	95 6⅝	726.6305	26 11½	4528.3612	26.9122
6	95 9¾	730.6183	27 0⅜	4553.2132	27.0599
7	96 0⅞	734.6147	27 1⅜	4578.1188	27.2079
8	96 4	738.6242	27 2¼	4603.1060	27.3934
9	96 7¼	742.6447	27 3⅛	4628.1617	27.5153
10	96 10⅜	746.6738	27 4	4653.2711	27.6545
11	97 1½	750.7161	27 4⅞	4678.4627	27.8043
31 *ft.*	97 4⅝	754.7694	27 5⅝	4703.7229	27.9544
1	97 7¾	758.8311	27 6⅝	4729.0354	28.1048
2	97 10⅞	762.9062	27 7½	4754.4314	28.2557
3	98 2	766.9921	27 8⅜	4779.8947	28.4070
4	98 5⅛	771.0866	27 9¼	4805.4116	28.5587
5	98 8⅜	775.1944	27 10⅛	4831.0115	28.7109
6	98 11½	779.3131	27 11⅛	4856.6792	28.8634
7	99 2⅝	783.4403	28 0	4882.3999	29.0163
8	99 5¾	787.5808	28 0⅞	4908.2035	29.1696
9	99 8⅞	791.7322	28 1¾	4934.0750	29.3234
10	100 0	795.8922	28 2⅝	4960.0001	29.4774
11	100 3⅛	800.0654	28 3½	4986.0075	29.6320
32 *ft.*	100 6⅜	804.2496	28 4¼	5012.0835	29.7870
1	100 9½	808.4422	28 5¼	5038.2117	29.9423
2	101 0⅝	812.6481	28 6⅛	5064.4229	30.0980
3	101 3¾	816.8650	28 7	5090.7026	30.2543
4	101 6⅞	821.0904	28 8	5117.0358	30.4107
5	101 10	825.3291	28 8⅞	5143.4509	30.5677
6	102 1⅛	829.5787	28 9¾	5169.9344	30.7251
7	102 4⅜	833.8368	28 10⅝	5196.4709	30.8828
8	102 7½	838.1082	28 11½	5223.0903	31.0410
9	102 10⅝	842.3905	29 0⅜	5249.7775	31.1996
10	103 1¾	846.6813	29 1¼	5277.0178	31.3585
11	103 4⅞	850.9855	29 2⅛	5303.3416	31.5179

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
33 *ft.*	103 8	855.3006	29 2⅜	5330.2333	31.6778
1	103 11⅛	859.6240	29 3⅞	5317.1767	31.8379
2	104 2¼	863.9609	29 4¾	5384.2043	31.9948
3	104 5⅜	868.3087	29 5¾	5411.2998	32.1595
4	104 8⅝	872.6649	29 6⅝	5438.4476	32.3579
5	104 11¾	877.0346	29 7½	5465.6796	32.4827
6	105 2⅞	881.4151	29 8⅜	5492.9789	32.6450
7	105 6	885.8040	29 9¼	5520.3305	32.8075
8	105 9⅛	890.2064	29 10⅛	5547.7662	32.9706
9	106 0¼	894.6196	29 11	5575.2693	33.1340
10	106 3⅜	899.0413	29 11⅞	5602.8253	33.2978
11	106 6⅝	903.4763	30 0¾	5630.4643	33.4613
34 *ft.*	106 9¾	907.9224	30 1½	5658.1723	33.6267
1	107 0⅞	912.3767	30 2½	5685.9315	33.7917
2	107 4	916.8445	30 3½	5713.7749	33.9572
3	107 7⅛	921.3232	30 4⅜	5741.6861	34.1231
4	107 10¼	925.8103	30 5¼	5769.6497	34.2892
5	108 1⅜	930.3108	30 6⅛	5797.6969	34.4559
6	108 4⅝	934.8223	30 7	5825.8115	34.6230
7	108 7¾	939.3421	30 7⅞	5853.9699	34.7904
8	108 10⅞	943.8753	30 8¾	5882.2308	34.9583
9	109 2	948.4195	30 9⅝	5910.5503	35.1266
10	109 5⅛	952.9720	30 10½	5938.9215	35.2952
11	109 8¼	957.5380	30 11⅜	5967.3768	35.4643
35 *ft.*	109 11⅜	962.1150	31 0¼	5989.9006	35.6339
1	110 2⅝	966.7001	31 1¼	6024.4750	35.8037
2	110 5¾	971.2989	31 2⅛	6053.1347	35.9740
3	110 8⅞	975.9085	31 3	6081.8617	36.1447
4	111 0	980.5264	31 3⅞	6110.6405	36.3158
5	111 3⅛	985.1579	31 4¾	6139.5040	36.4873
6	111 6¼	989.8003	31 5⅝	6168.4354	36.6592
7	111 9⅜	994.4509	31 6½	6197.4180	36.8315
8	112 0½	999.1151	31 7⅜	6226.4833	37.0042
9	112 3¾	1003.7902	31 8¼	6256.6205	37.1404
10	112 6⅞	1008.4736	31 9⅛	6284.8074	37.3509
11	112 10	1013.1705	31 10⅛	6314.0785	37.5248
36 *ft.*	113 1⅛	1017.8784	31 10⅞	6343.4181	37.6992
1	113 4¼	1022.5944	31 11⅞	6372.8083	37.8738
2	113 7⅜	1027.3240	32 0¾	6403.2831	38.0490
3	113 10⅝	1032.0646	32 1⅝	6431.8265	38.2246
4	114 1¾	1036.8134	32 2½	6461.4211	38.4005
5	114 4⅞	1041.5758	32 3⅜	6491.1003	38.5761
6	114 8	1046.3491	32 4¼	6520.8475	38.7537
7	114 11⅛	1051.1306	32 5⅛	6550.6458	38.9307
8	115 2¼	1055.9257	32 6	6580.5289	39.1083
9	115 5⅜	1060.7317	32 6⅞	6610.4799	39.2863
10	115 9¼	1065.5459	32 7⅞	6640.4820	39.4646
11	115 11⅝	1070.3738	32 8¾	6670.5695	39.6435

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
37 *ft.*	116 2⅞	1075.2126	32 9½	6700.7249	39.8227
1	116 6	1080.0594	32 10½	6730.9301	40.0220
2	116 9⅛	1084.9201	32 11⅝	6762.2220	40.1822
3	117 0¼	1089.7915	33 0¼	6791.5806	40.3626
4	117 3½	1094.6711	33 1⅛	6821.9902	40.5434
5	117 6½	1099.5644	33 2	6852.4853	40.7246
6	117 9⅝	1104.4687	33 2⅞	6883.0489	40.9062
7	118 0¾	1109.3810	33 3¾	6913.6623	41.0882
8	118 4	1114.3071	33 4⅝	6944.3618	41.2706
9	118 7⅛	1119.2440	33 5⅝	6975.1286	41.4535
10	118 10¼	1124.1891	33 6½	7005.9464	41.6366
11	119 1⅜	1129.1478	33 7⅜	7036.8490	41.8203
38 *ft.*	119 4½	1134.1176	33 8⅛	7067.8208	42.0043
1	119 7⅝	1139.0953	33 9⅛	7098.8419	42.1887
2	119 10¾	1144.0868	33 10	7129.9489	42.3736
3	120 2	1149.0892	33 10⅞	7161.1238	42.5588
4	120 5⅛	1154.0997	33 11¾	7192.3493	42.7444
5	120 8⅜	1159.1239	34 0⅝	7223.6601	42.9305
6	120 11⅜	1164.1591	34 1½	7255.0395	43.1459
7	121 2½	1169.2023	34 2⅜	7286.4687	43.3034
8	121 5⅝	1174.2592	34 3⅜	7317.9833	43.4911
9	121 8¾	1179.3271	34 4¼	7349.5664	43.6417
10	121 11⅞	1184.4030	34 5⅛	7381.1994	43.8668
11	122 3⅛	1189.4927	34 6	7412.9185	44.0553
39 *ft.*	122 6¼	1194.5934	34 6¾	7444.7054	44.2442
1	122 9½	1199.7195	34 7¾	7476.6519	44.4340
2	123 0½	1204.8244	34 8⅝	7478.4626	44.6231
3	123 3⅝	1209.9577	34 9½	7540.4563	44.8123
4	123 6¾	1215.0990	34 10⅝	7572.4969	45.0036
5	123 9⅞	1220.2542	34 11¼	7604.6239	45.1946
6	124 1⅛	1225.4203	35 0⅛	7636.8193	45.3859
7	124 4¼	1230.5943	35 1⅛	7669.0636	45.5775
8	124 7⅜	1235.7822	35 2	7701.3946	45.7697
9	124 10½	1240.9810	35 2⅞	7733.7935	45.9622
10	125 1⅝	1246.1878	35 3¾	7766.2423	46.1551
11	125 4⅞	1251.4084	35 4⅝	7798.7771	46.3484
40 *ft.*	125 7⅞	1256.6400	35 5⅝	7831.3804	46.5422
1	125 11	1261.8794	35 6⅝	7864.0324	46.7362
2	126 2¼	1267.1327	35 7¼	7896.7709	46.9308
3	126 5⅝	1272.3970	35 8⅛	7929.5781	47.1257
4	126 8½	1277.6692	35 9	7962.4344	47.3211
5	126 11⅝	1282.9553	35 10	7995.3774	47.5168
6	127 2¾	1288.2523	35 10⅞	8028.2883	47.7130
7	127 5⅞	1293.5572	35 11¾	8061.4484	47.9095
8	127 9	1298.8760	36 0⅝	8094.5952	48.1065
9	128 0¼	1304.2057	36 1⅛	8127.8099	48.3039
10	128 3⅜	1309.5433	36 2⅜	8161.0738	48.5016
11	128 6½	1314.8949	36 3¼	8194.4250	48.6998

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41 *ft.*	128 9⅝	1320.2574	36 4½	8227.8441	48.8984
1	129 0¾	1325.6276	36 5	8261.3112	49.0973
2	129 3⅞	1331.0119	36 5⅜	8294.8661	49.2967
3	129 7	1336.4071	36 6¾	8328.4890	49.4965
4	129 10⅛	1341.8101	36 7¾	8362.1605	49.6967
5	130 1⅜	1347.2271	36 8⅝	8395.9192	49.8973
6	130 4½	1352.6551	36 9½	8429.7465	50.0983
7	130 7⅝	1358.0908	36 10⅜	8463.6218	50.2997
8	130 10¾	1363.5406	36 11¼	8497.5850	50.5015
9	131 1⅞	1369.0012	37 0⅛	8531.6154	50.7037
10	131 5	1374.4697	37 1	8565.6951	50.9063
11	131 8⅛	1379.9521	37 1⅞	8599.8614	51.1093
42 *ft.*	131 11⅜	1385.4456	37 2⅝	8634.0969	51.3128
1	132 2½	1390.2467	37 3⅝	8664.0174	51.4906
2	132 5⅝	1396.4619	37 4½	8702.7505	51.7208
3	132 8¾	1401.9880	37 5½	8737.1892	51.9257
4	132 11⅞	1407.5219	37 6⅝	8771.6764	52.1304
5	133 3	1413.0698	37 7¼	8806.2509	52.3355
6	133 6⅛	1418.6287	37 8⅛	8840.8940	52.5418
7	133 9¼	1424.1952	37 9	8875.5844	52.7479
8	134 0½	1429.7759	37 9⅞	8910.3634	52.9546
9	134 3⅝	1435.3675	37 10¾	8945.2102	53.1618
10	134 6¾	1440.9668	37 11⅝	8980.1050	53.3691
11	134 9⅞	1446.5802	38 0½	9015.0878	53.5770
43 *ft.*	135 1	1452.2046	38 1¼	9050.1390	53.7853
1	135 4⅛	1457.8365	38 2¼	9085.2370	53.9939
2	135 7¼	1463.4827	38 3¼	9120.3741	54.2030
3	135 10½	1469.1397	38 4⅛	9155.6786	54.4126
4	136 1⅛	1474.8044	38 5	9190.9810	54.6224
5	136 4¾	1480.4833	38 5⅞	9226.3719	54.8323
6	136 7⅞	1486.1731	38 6¾	9261.7307	55.0434
7	136 11	1491.8705	38 7⅝	9297.3369	55.2544
8	137 2⅛	1497.5821	38 8½	9332.9316	55.8363
9	137 5¼	1503.3046	38 9⅜	9368.5942	55.6779
10	137 8⅜	1509.0348	38 10¼	9404.3048	55.8902
11	137 11⅝	1514.7791	38 11⅛	9440.1033	56.1029
44 *ft.*	138 2¾	1520.5344	38 11⅞	9475.9703	56.3161
1	138 5⅞	1526.2971	39 1	9511.8835	56.5295
2	138 9	1532.0742	39 1⅞	9547.8864	56.7435
3	139 0⅛	1537.8622	39 2¾	9583.9572	56.9578
4	139 3¼	1543.6578	39 3⅝	9620.0754	57.1725
5	139 6⅜	1549.4676	39 4½	9656.2820	57.3877
6	139 9⅝	1555.2883	39 5⅜	9692.5566	57.6033
7	140 0¾	1561.1165	39 6¼	9728.8780	57.8191
8	140 3⅞	1566.9391	39 7⅛	9765.2891	58.0355
9	140 7½	1572.8125	39 8	9801.7675	58.2523
10	140 10⅛	1578.6735	39 8⅞	9838.2932	58.4823
11	141 1¼	1584.5488	39 9¾	9874.9081	58.6499

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
45 *ft.*	141 4⅜	1590.4350	39 10½	9911.5909	58.9050
1	141 7½	1596.3286	39 11⅝	9948.3198	59.1233
2	141 10¾	1602.2366	40 0½	9985.1384	59.3421
3	142 1⅞	1608.1555	40 1⅜	10022.025	59.5613
4	142 5	1614.0819	40 2¼	10058.958	59.7808
5	142 8⅛	1620.0226	40 3⅛	10095.980	60.0008
6	142 11¼	1625.9743	40 4	10133.071	60.2212
7	143 2⅜	1631.9334	40 4⅞	10170.208	60.4420
8	143 5½	1637.9068	40 5¾	10207.435	60.6632
9	143 8¾	1643.8912	40 6⅝	10244.729	60.8848
10	143 11⅞	1649.8831	40 7⅝	10277.070	61.1068
11	144 3	1655.8892	40 8½	10319.501	61.3292
46 *ft.*	144 6⅛	1661.9064	40 9⅜	10357.000	61.5521
1	144 9¼	1667.9308	40 10¼	10394.544	61.7752
2	145 0⅜	1673.9698	40 11⅛	10432.179	61.9989
3	145 3½	1680.0196	41 0	10469.880	62.2229
4	145 6⅝	1686.0769	41 0⅞	10507.631	62.4473
5	145 9⅞	1692.1485	41 1¾	10546.469	62.6722
6	146 1⅛	1698.2311	41 2⅝	10583.376	62.8974
7	146 4½	1704.3210	41 3½	10621.328	63.1230
8	146 7¼	1710.4254	41 4⅜	10659.371	63.3491
9	146 10⅜	1716.5407	41 5⅜	10697.481	63.5756
10	147 1½	1722.6634	41 6¼	10735.638	63.8021
11	147 4⅝	1728.8005	41 7⅛	10773.884	64.0296
47 *ft.*	147 7¾	1734.9486	41 7¾	10812.199	64.2573
1	147 11	1741.1039	41 8⅞	10850.559	64.4853
2	148 2⅛	1747.2738	41 9¾	10889.010	64.7138
3	148 5¼	1753.4545	41 10⅝	10927.528	64.9427
4	148 8⅜	1759.6426	41 11½	10966.092	65.1719
5	148 11½	1765.8452	42 0⅜	11004.747	65.4017
6	149 2⅝	1772.0587	42 1¼	11043.469	65.6318
7	149 5⅞	1778.2795	42 2⅛	11082.237	65.8622
8	149 8⅞	1784.5148	42 3⅛	11121.096	66.0931
9	150 0⅛	1790.7610	42 4	11160.022	66.3245
10	150 3¼	1797.0145	42 4⅞	11197.994	66.5561
11	150 6⅜	1803.2826	42 5¾	11238.057	66.7882
48 *ft.*	150 9½	1809.5616	42 6½	11287.187	67.0208
1	151 0⅝	1815.8477	42 7½	11316.362	67.2536
2	151 3¾	1822.1485	42 8⅜	11336.629	67.4870
3	151 6⅞	1828.4602	42 9¼	11394.963	67.7209
4	151 10⅛	1834.7791	42 10⅛	11434.343	67.9548
5	152 1¼	1841.1127	42 11	11473.814	68.1893
6	152 4⅜	1847.4571	43 0	11513.352	68.4243
7	152 7½	1853.8087	43 0⅞	11552.935	68.6560
8	152 10⅝	1860.1750	43 1¾	11592.610	68.8953
9	153 1¾	1866.5521	43 2⅝	11632.352	69.1315
10	153 4⅞	1872.9365	43 3½	11672.140	69.3680
11	153 8⅛	1879.3355	43 4⅜	11712.018	69.6050

Dia. in feet & inches.	Circum. in feet and inches.	Area in feet.	Side of = square in ft. and in.	Gallons at 1 foot in depth.	Cubic yards at 1 foot in depth.
49 *ft.*	153 11¼	1885.7454	43 5⅛	11750.964	69.8424
1	154 2⅜	1892.1724	43 6⅛	11792.018	70.0804
2	154 5½	1898.5041	43 7	11831.477	70.3150
3	154 8⅝	1905.0367	43 7⅞	11872.188	70.5569
4	154 11⅞	1911.4965	43 8¾	11912.446	70.7961
5	155 2⅞	1917.9609	43 9¾	11952.732	71.0356
6	155 6	1924.4263	43 10⅝	11993.824	71.2750
7	155 9¼	1930.9188	43 11⅛	12033.485	71.5155
8	156 0⅛	1937.3159	44 0⅞	12073.352	71.7524
9	156 3½	1943.9140	44 1¼	12114.472	71.9968
10	156 6⅝	1950.4392	44 2⅛	12155.137	72.2385
11	156 9¾	1956.9691	44 3	12195.831	72.4803
50 *ft.*	157 0⅞	1963.5000	44 3¾	12236.532	72.7222

TABLE

CONTAINING

THE SQUARE & CUBE ROOTS OF ALL NUMBERS

From 1 *to* 1000; *and the*

DIFFERENCE EXISTING BETWEEN EACH ROOT,

BY WHICH

The process for obtaining the roots of numbers, consisting of integers and decimals, is considerably facilitated.

RULE.—Multiply the difference between the root of the integer part of the given number, and the root of the next higher integer number, by the decimal part of the given number, and add the product to the root of the integer number given, the sum is the root required.

EXAMPLE 1.—Required the square root of 53.75.

Difference by table = .0683 × .75 = .051225, and the root of 53 = 7.2801,—hence, 7.2801 + .051225 = 7.3313, the root required.

EXAMPLE 2.—Required the cube root of the number 734.26.

Difference by table = .0041 × .26 = .001066, and the root of 734 = 9.0205,—hence, 9.0205 + .001066 = 9.0215, the root required.

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
1	1.0000		1.0000		45	6.7082		3.5568	
		.4142		.2599			.0741		.0262
2	1.4142	.3178	1.2599	.1823	46	6.7823	.0733	3.5830	.0258
3	1.7320	.2680	1.4422	.1452	47	6.8556	.0726	3.6088	.0254
4	2.0000	.2360	1.5874	.1225	48	6.9282	.0718	3.6342	.0251
5	2.2360	.2134	1.7099	.1072	49	7.0000	.0710	3.6593	.0247
6	2.4494	.1963	1.8171	.0950	50	7.0710	.0704	3.6840	.0244
7	2.6457	.1827	1.9129	.0871	51	7.1414	.0697	3.7084	.0241
8	2.8284	.1716	2.0000	.0800	52	7.2111	.0690	3.7325	.0237
9	3.0000	.1622	2.0800	.0744	53	7.2801	.0683	3.7562	.0236
10	3.1622	.1544	2.1544	.0685	54	7.3484	.0677	3.7797	.0232
11	3.3166	.1475	2.2239	.0655	55	7.4161	.0672	3.8029	.0229
12	3.4641	.1414	2.2894	.0619	56	7.4833	.0665	3.8258	.0227
13	3.6055	.1361	2.3513	.0588	57	7.5498	.0659	3.8485	.0223
14	3.7416	.1313	2.4101	.0551	58	7.6157	.0654	3.8708	.0221
15	3.8729	.1271	2.4662	.0536	59	7.6811	.0648	3.8929	.0219
16	4.0000	.1231	2.5198	.0514	60	7.7459	.0643	3.9148	.0216
17	4.1231	.1195	2.5712	.0595	61	7.8102	.0638	3.9364	.0214
18	4.2426	.1162	2.6207	.0477	62	7.8740	.0632	3.9578	.0212
19	4.3588	.1133	2.6684	.0460	63	7.9372	.0628	3.9790	.0210
20	4.4721	.1104	2.7144	.0445	64	8.0000	.0622	4.0000	.0207
21	4.5825	.1079	2.7589	.0431	65	8.0622	.0618	4.0207	.0205
22	4.6904	.1054	2.8020	.0418	66	8.1240	.0613	4.0412	.0203
23	4.7958	.1031	2.8438	.0406	67	8.1853	.0609	4.0615	.0201
24	4.8989	.1011	2.8844	.0396	68	8.2462	.0604	4.0816	.0199
25	5.0000	.0990	2.9240	.0384	69	8.3066	.0600	4.1015	.0197
26	5.0990	.0971	2.9624	.0376	70	8.3666	.0595	4.1212	.0196
27	5.1961	.0954	3.0000	.0365	71	8.4261	.0591	4.1408	.0193
28	5.2915	.0936	3.0365	.0358	72	8.4852	.0588	4.1601	.0192
29	5.3851	.0921	3.0723	.0349	73	8.5440	.0583	4.1793	.0190
30	5.4772	.0905	3.1072	.0341	74	8.6023	.0579	4.1983	.0188
31	5.5677	.0891	3.1413	.0325	75	8.6602	.0565	4.2171	.0187
32	5.6568	.0877	3.1748	.0327	76	8.7177	.0572	4.2358	.0185
33	5.7445	.0864	3.2075	.0321	77	8.7749	.0568	4.2543	.0183
34	5.8309	.0851	3.2396	.0314	78	8.8317	.0564	4.2726	.0182
35	5.9160	.0840	3.2710	.0309	79	8.8881	.0561	4.2908	.0180
36	6.0000	.0827	3.3019	.0303	80	8.9442	.0558	4.3088	.0179
37	6.0827	.0817	3.3322	.0297	81	9.0000	.0553	4.3267	.0177
38	6.1644	.0805	3.3619	.0293	82	9.0553	.0551	4.3444	.0176
39	6.2449	.0796	3.3912	.0287	83	9.1104	.0547	4.3620	.0175
40	6.3245	.0786	3.4199	.0283	84	9.1651	.0544	4.3795	.0173
41	6.4031	.0776	3.4482	.0278	85	9.2195	.0541	4.3968	.0172
42	6.4807	.0767	3.4760	.0273	86	9.2736	.0537	4.4140	.0170
43	6.5574	.0758	3.5033	.0270	87	9.3273	.0535	4.4310	.0169
44	6.6332	.0750	3.5303	.0265	88	9.3808	.0531	4.4479	.0168
45	6.7082		3.5568		89	9.4339		4.4647	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
89	9.4339	.0529	4.4647	.0167	137	11.7046	.0427	5.1551	.0125
90	9.4868	.0525	4.4814	.0165	138	11.7473	.0425	5.1676	.0125
91	9.5393	.0523	4.4979	.0164	139	11.7898	.0423	5.1801	.0123
92	9.5916	.0520	4.5143	.0163	140	11.8321	.0422	5.1924	.0124
93	9.6436	.0517	4.5306	.0162	141	11.8743	.0420	5.2048	.0123
94	9.6953	.0514	4.5468	.0161	142	11.9163	.0419	5.2171	.0122
95	9.7467	.0512	4.5629	.0159	143	11.9582	.0418	5.2293	.0121
96	9.7979	.0589	4.5788	.0159	144	12.0000	.0415	5.2414	.0121
97	9.8488	.0506	4.5947	.0157	145	12.0415	.0414	5.2535	.0121
98	9.8994	.0504	4.6104	.0156	146	12.0830	.0413	5.2656	.0120
99	9.9498	.0502	4.6260	.0155	147	12.1243	.0412	5.2776	.0119
100	10.0000	.0498	4.6415	.0155	148	12.1655	.0410	5.2895	.0119
101	10.0498	.0497	4.6570	.0153	149	12.2065	.0409	5.3014	.0118
102	10.0995	.0493	4.6723	.0153	150	12.2474	.0408	5.3132	.0118
103	10.1488	.0492	4.6875	.0151	151	12.2882	.0406	5.3250	.0118
104	10.1980	.0489	4.7026	.0150	152	12.3288	.0405	5.3368	.0116
105	10.2469	.0487	4.7176	.0150	153	12.3693	.0403	5.3484	.0117
106	10.2956	.0484	4.7326	.0148	154	12.4096	.0402	5.3601	.0115
107	10.3440	.0483	4.7474	.0148	155	12.4498	.0401	5.3716	.0116
108	10.3923	.0480	4.7622	.0146	156	12.4899	.0400	5.3832	.0114
109	10.4403	.0477	4.7768	.0146	157	12.5299	.0399	5.3946	.0115
110	10.4880	.0476	4.7914	.0144	158	12.5698	.0397	5.4061	.0114
111	10.5356	.0474	4.8058	.0144	159	12.6095	.0396	5.4175	.0113
112	10.5830	.0471	4.8202	.0143	160	12.6491	.0394	5.4288	.0113
113	10.6301	.0469	4.8345	.0143	161	12.6885	.0394	5.4401	.0112
114	10.6770	.0468	4.8488	.0141	162	12.7279	.0392	5.4513	.0112
115	10.7238	.0465	4.8629	.0140	163	12.7671	.0391	5.4625	.0112
116	10.7703	.0463	4.8769	.0140	164	12.8062	.0390	5.4737	.0111
117	10.8166	.0461	4.8909	.0139	165	12.8452	.0389	5.4848	.0110
118	10.8627	.0460	4.9048	.0138	166	12.8840	.0388	5.4958	.0110
119	10.9087	.0467	4.9186	.0138	167	12.9228	.0387	5.5068	.0110
120	10.9544	.0456	4.9324	.0136	168	12.9614	.0386	5.5178	.0109
121	11.0000	.0453	4.9460	.0136	169	13.0000	.0384	5.5287	.0109
122	11.0453	.0452	4.9596	.0135	170	13.0384	.0382	5.5396	.0108
123	11.0905	.0450	4.9731	.0135	171	13.0766	.0382	5.5504	.0108
124	11.1355	.0448	4.9866	.0134	172	13.1148	.0381	5.5612	.0108
125	11.1803	.0446	5.0000	.0132	173	13.1529	.0380	5.5720	.0107
126	11.2249	.0445	5.0132	.0133	174	13.1909	.0378	5.5827	.0107
127	11.2694	.0443	5.0265	.0131	175	13.2287	.0377	5.5934	.0106
128	11.3137	.0441	5.0396	.0131	176	13.2664	.0376	5.6040	.0106
129	11.3578	.0439	5.0527	.0130	177	13.3041	.0375	5.6146	.0106
130	11.4017	.0438	5.0657	.0130	178	13.3416	.0374	5.6252	.0105
131	11.4455	.0436	5.0787	.0129	179	13.3790	.0373	5.6357	.0105
132	11.4891	.0434	5.0916	.0128	180	13.4164	.0372	5.6462	.0104
133	11.5325	.0433	5.1044	.0128	181	13.4536	.0371	5.6566	.0104
134	11.5758	.0431	5.1172	.0127	182	13.4907	.0370	5.6670	.0104
135	11.6189	.0430	5.1299	.0126	183	13.5277	.0369	5.6774	.0103
136	11.6619	.0428	5.1425	.0126	184	13.5646	.0368	5.6877	.0103
137	11.7046		5.1551		185	13.6014		5.6980	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
185	13.6014	.0367	5.6980	.0102	233	15.2643	.0327	6.1534	.0088
186	13.6381	.0366	5.7082	.0102	234	15.2970	.0327	6.1622	.0088
187	13.6747	.0365	5.7184	.0102	235	15.3297	.0325	6.1710	.0087
188	13.7113	.0364	5.7286	.0101	236	15.3622	.0326	6.1797	.0087
189	13.7477	.0363	5.7387	.0101	237	15.3948	.0324	6.1884	.0087
190	13.7840	.0362	5.7488	.0101	238	15.4272	.0324	6.1971	.0087
191	13.8202	.0361	5.7589	.0100	239	15.4596	.0323	6.2058	.0086
192	13.8564	.0360	5.7689	.0100	240	15.4919	.0322	6.2144	.0086
193	13.8924	.0359	5.7789	.0100	241	15.5241	.0322	6.2230	.0086
194	13.9283	.0358	5.7889	.0099	242	15.5563	.0321	6.2316	.0086
195	13.9642	.0357	5.7988	.0099	243	15.5884	.0320	6.2402	.0085
196	14.0000	.0356	5.8087	.0099	244	15.6204	.0320	6.2487	.0086
197	14.0356	.0356	5.8186	.0098	245	15.6524	.0319	6.2573	.0085
198	14.0712	.0355	5.8284	.0098	246	15.6843	.0319	6.2658	.0085
199	14.1067	.0354	5.8382	.0098	247	15.7162	.0318	6.2743	.0084
200	14.1421	.0353	5.8480	.0097	248	15.7480	.0317	6.2827	.0084
201	14.1774	.0352	5.8577	.0097	249	15.7797	.0316	6.2911	.0085
202	14.2126	.0351	5.8674	.0097	250	15.8113	.0316	6.2996	.0083
203	14.2478	.0350	5.8771	.0096	251	15.8429	.0316	6.3079	.0084
204	14.2828	.0350	5.8867	.0096	252	15.8745	.0314	6.3163	.0084
205	14.3178	.0349	5.8963	.0096	253	15.9059	.0314	6.3247	.0083
206	14.3527	.0348	5.9059	.0095	254	15.9373	.0314	6.3330	.0083
207	14.3874	.0347	5.9154	.0095	255	15.9687	.0313	6.3413	.0083
208	14.4222	.0346	5.9249	.0095	256	16.0000	.0312	6.3496	.0082
209	14.4568	.0345	5.9344	.0095	257	16.0312	.0311	6.3578	.0082
210	14.4913	.0345	5.9439	.0094	258	16.0623	.0311	6.3660	.0083
211	14.5258	.0344	5.9533	.0094	259	16.0934	.0311	6.3743	.0082
212	14.5602	.0343	5.9627	.0093	260	16.1245	.0309	6.3825	.0081
213	14.5945	.0342	5 9720	.0094	261	16.1554	.0310	6.3906	.0082
214	14.6287	.0341	5.9814	.0093	262	16.1864	.0308	6.3988	.0081
215	14.6628	.0341	5.9907	.0093	263	16.2172	.0308	6.4069	.0081
216	14.6969	.0340	6.0000	.0093	264	16.2480	.0308	6.4150	.0081
217	14.7309	.0339	6.0092	.0092	265	16.2788	.0307	6.4231	.0081
218	14.7648	.0338	6.0184	.0092	266	16.3095	.0306	6.4312	.0080
219	14.7986	.0337	6.0276	.0092	267	16.3401	.0306	6.4392	.0081
220	14.8323	.0337	6.0368	.0091	268	16.3707	.0305	6.4473	.0080
221	14.8660	.0336	6.0459	.0091	269	16.4012	.0304	6.4553	.0080
222	14.8996	.0335	6.0550	.0091	270	16.4316	.0304	6.4633	.0078
223	14.9331	.0335	6.0641	.0090	271	16.4620	.0304	6.4712	.0080
224	14.9666	.0334	6.0731	.0091	272	16.4924	.0303	6.4792	.0079
225	15.0000	.0332	6.0822	.0089	273	16.5227	.0302	6.4871	.0079
226	15.0332	.0333	6.0911	.0090	274	16.5529	.0302	6.4950	.0079
227	15.0665	.0331	6.1001	.0090	275	16.5831	.0301	6.5029	.0079
228	15.0996	.0331	6.1091	.0089	276	16.6132	.0301	6.5108	.0078
229	15.1327	.0330	6.1180	.0089	277	16.6433	.0300	6.5186	.0079
230	15.1657	.0329	6.1269	.0088	278	16.6733	.0299	6.5265	.0078
231	15.1986	.0329	6.1357	.0089	279	16.7032	.0300	6.5343	.0078
232	15.2315	.0328	6.1446	.0088	280	16.7332	.0298	6.5421	.0078
233	15.2643		6.1534		281	16.7630		6.5499	

No.	Sqr Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
281	16.7630	.0298	6.5499	.0077	329	18.1383	.0276	6.9034	.0070
282	16.7928	.0298	6.5576	.0078	330	18.1659	.0275	6.9104	.0069
283	16.8226	.0296	6.5654	.0077	331	18.1934	.0274	6.9173	.0070
284	16.8522	.0297	6.5731	.0077	332	18.2208	.0274	6.9243	.0070
285	16.8819	.0296	6.5808	.0077	333	18.2482	.0274	6.9313	.0070
286	16.9115	.0295	6.5885	.0077	334	18.2756	.0274	6.9383	.0068
287	16.9410	.0295	6.5962	.0076	335	18.3030	.0273	6.9451	.0069
288	16.9705	.0295	6.6038	.0076	336	18.3303	.0272	6.9520	.0069
289	17.0000	.0293	6.6114	.0077	337	18.3575	.0272	6.9589	.0069
290	17.0293	.0294	6.6191	.0076	338	18.3847	.0272	6.9658	.0068
291	17.0587	.0293	6.6267	.0075	339	18.4119	.0271	6.9726	.0069
292	17.0880	.0292	6.6342	.0076	340	18.4390	.0271	6.9795	.0068
293	17.1172	.0292	6.6418	.0075	341	18.4661	.0271	6.9863	.0068
294	17.1464	.0291	6.6493	.0076	342	18.4932	.0270	6.9931	.0069
295	17.1755	.0291	6.6569	.0075	343	18.5202	.0270	7.0000	.0067
296	17.2046	.0290	6.6644	.0075	344	18.5472	.0269	7.0067	.0068
297	17.2336	.0290	6.6719	.0075	345	18.5741	.0269	7.0135	.0068
298	17.2626	.0290	6.6794	.0074	346	18.6010	.0269	7.0203	.0068
299	17.2916	.0289	6.6868	.0075	347	18.6279	.0268	7.0271	.0067
300	17.3205	.0288	6.6943	.0074	348	18.6547	.0268	7.0338	.0067
301	17.3493	.0288	6.7017	.0074	349	18.6815	.0268	7.0405	.0067
302	17.3781	.0287	6.7091	.0074	350	18.7082	.0267	7.0472	.0068
303	17.4068	.0287	6.7165	.0074	351	18.7349	.0267	7.0540	.0066
304	17.4355	.0287	6.7239	.0074	352	18.7616	.0266	7.0606	.0067
305	17.4642	.0286	6.7313	.0073	353	18.7882	.0266	7.0673	.0067
306	17.4928	.0286	6.7386	.0073	354	18.8148	.0266	7.0740	.0066
307	17.5214	.0285	6.7459	.0074	355	18.8414	.0265	7.0806	.0067
308	17.5499	.0284	6.7533	.0073	356	18.8679	.0265	7.0873	.0066
309	17.5783	.0285	6.7606	.0072	357	18.8944	.0264	7.0939	.0066
310	17.6068	.0283	6.7678	.0073	358	18.9208	.0264	7.1005	.0066
311	17.6351	.0284	6.7751	.0073	359	18.9472	.0264	7.1071	.0066
312	17.6635	.0283	6.7824	.0072	360	18.9736	.0264	7.1137	.0066
313	17.6918	.0282	6.7896	.0072	361	19.0000	.0262	7.1203	.0066
314	17.7200	.0282	6.7968	.0072	362	19.0262	.0263	7.1269	.0065
315	17.7482	.0281	6.8040	.0072	363	19.0525	.0262	7.1334	.0066
316	17.7763	.0281	6.8112	.0072	364	19.0787	.0262	7.1400	.0065
317	17.8044	.0281	6.8184	.0072	365	19.1049	.0262	7.1465	.0065
318	17.8325	.0280	6.8256	.0071	366	19.1311	.0261	7.1530	.0065
319	17.8605	.0280	6.8327	.0072	367	19.1572	.0261	7.1595	.0065
320	17.8885	.0279	6.8399	.0071	368	19.1833	.0260	7.1660	.0065
321	17.9164	.0279	6.8470	.0071	369	19.2093	.0260	7.1725	.0065
322	17.9443	.0279	6.8541	.0071	370	19.2353	.0260	7.1790	.0065
323	17.9722	.0278	6.8612	.0070	371	19.2613	.0260	7.1855	.0064
324	18.0000	.0277	6.8682	.0071	372	19.2873	.0259	7.1919	.0065
325	18.0277	.0277	6.8753	.0070	373	19.3132	.0258	7.1984	.0064
326	18.0554	.0277	6.8823	.0071	374	19.3390	.0259	7.2048	.0064
327	18.0831	.0276	6.8894	.0070	375	19.3649	.0258	7.2112	.0064
328	18.1107	.0276	6.8964	.0070	376	19.3907	.0257	7.2176	.0064
329	18.1383		6.9034		377	19.4164		7.2240	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
377	19.4164	.0258	7.2240	.0064	425	20.6155	.0242	7.5184	.0059
378	19.4422	.0257	7.2304	.0063	426	20.6397	.0242	7.5243	.0059
379	19.4679	.0256	7.2367	.0064	427	20.6639	.0242	7.5302	.0059
380	19.4935	.0257	7.2431	.0064	428	20.6881	.0242	7.5361	.0058
381	19.5192	.0256	7.2495	.0063	429	20.7123	.0241	7.5419	.0059
382	19.5448	.0255	7.2558	.0063	430	20.7364	.0241	7.5478	.0058
383	19.5703	.0256	7.2621	.0063	431	20.7605	.0241	7.5536	.0059
384	19.5959	.0255	7.2684	.0063	432	20.7846	.0240	7.5595	.0058
385	19.6214	.0254	7.2747	.0063	433	20.8086	.0240	7.5653	.0058
386	19.6468	.0255	7.2810	.0063	434	20.8326	.0240	7.5711	.0058
387	19.6723	.0254	7.2873	.0063	435	20.8566	.0240	7.5769	.0058
388	19.6977	.0253	7.2936	.0062	436	20.8806	.0239	7.5827	.0058
389	19.7230	.0254	7.2998	.0063	437	20.9045	.0239	7.5885	.0058
390	19.7484	.0253	7.3061	.0062	438	20.9284	.0239	7.5943	.0058
391	19.7737	.0252	7.3123	.0063	439	20.9523	.0238	7.6001	.0058
392	19.7989	.0253	7.3186	.0062	440	20.9761	.0239	7.6059	.0057
393	19.8242	.0252	7.3248	.0062	441	21.0000	.0237	7.6116	.0058
394	19.8494	.0252	7.3310	.0062	442	21.0237	.0220	7.6174	.0057
395	19.8746	.0251	7.3372	.0062	443	21.0457	.0256	7.6231	.0057
396	19.8997	.0251	7.3434	.0061	444	21.0713	.0237	7.6288	.0058
397	19.9248	.0251	7.3495	.0062	445	21.0950	.0237	7.6346	.9057
398	19.9499	.0250	7.3557	.0062	446	21.1187	.0236	7.6403	.0057
399	19.9749	.0251	7.3619	.0061	447	21.1423	.0237	7.6460	.0057
400	20.0000	.0249	7.3680	.0061	448	21.1660	.0236	7.6517	.0057
401	20.0249	.0250	7.3741	.0062	449	21.1896	.0236	7.6574	.0056
402	20.0499	.0249	7.3803	.0061	450	21.2132	.0225	7.6630	.0057
403	20.0748	.0249	7.3864	.0061	451	21.2367	.0235	7.6687	.0057
404	20.0997	.0249	7.3925	.0061	452	21.2602	.0235	7.6744	.0056
405	20.1246	.0248	7.3986	.0061	453	21.2837	.0235	7.6800	.0057
406	20.1494	.0248	7.4047	.0060	454	21.3072	.0235	7.6857	.0056
407	20.1742	.0248	7.4107	.0061	455	21.3307	.0234	7.6913	.0057
408	20.1990	.0247	7.4168	.0061	456	21.3541	.0234	7.6970	.0056
409	20.2237	.0247	7.4229	.0060	457	21.3775	.0234	7.7026	.0056
410	20.2484	.0247	7.4289	.0060	458	21.4009	.0233	7.7082	.0056
411	20.2731	.0246	7.4349	.0061	459	21.4242	.0234	7.7138	.0056
412	20.2977	.0247	7.4410	.0060	460	21.4476	.0233	7.7194	.0056
413	20.3224	.0245	7.4470	.0060	461	21.4709	.0232	7.7250	.0056
414	20.3469	.0246	7.4530	.0060	462	21.4941	.0233	7.7306	.0055
415	20.3715	.0245	7.4590	.0060	463	21.5174	.0232	7.7361	.0056
416	20.3960	.0245	7.4650	.0059	464	21.5406	.0232	7.7417	.0056
417	20.4205	.0245	7.4709	.0060	465	21.5638	.0232	7.7473	.0055
418	20.4450	.0244	7.4769	.0060	466	21.5870	.0231	7.7528	.0056
419	20.4694	.0245	7.4829	.0059	467	21.6101	.0232	7.7584	.0055
420	20.4939	.0243	7.4888	.0060	468	21.6333	.0231	7.7639	.0055
421	20.5182	.0244	7.4948	.0059	469	21.6564	.0230	7.7694	.0055
422	20.5426	.0243	7.5007	.0059	470	21.6794	.0231	7.7749	.0055
423	20.5669	.0243	7.5066	.0059	471	21.7025	.0230	7.7804	.0055
424	20.5912	.0243	7.5125	.0059	472	21.7255	.0230	7.7859	.0055
425	20.6155		7.5184		473	21.7485		7.7914	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
473	21.7485		7.7914		521	22.8254		8.0466	
		.0230		.0055			.0219		.0051
474	21.7715		7.7969		522	22.8473		8.0517	
		.0229		.0055			.0218		.0051
475	21.7944		7.8024		523	22.8691		8.0568	
		.0230		.0055			.0219		.0052
476	21.8174		7.8079		524	22.8910		8.0620	
		.0229		.0055			.0218		.0051
477	21.8403		7.8133		525	22.9128		8.0671	
		.0229		.0054			.0218		.0051
478	21.8632		7.8188		526	22.9346		8.0722	
		.0228		.0055			.0218		.0051
479	21.8860		7.8242		527	22.9564		8.0773	
		.0229		.0054			.0218		.0051
480	21.9089		7.8297		528	22.9782		8.0824	
		.0228		.0055			.0218		.0051
481	21.9317		7.8351		529	23.0000		8.0875	
		.0227		.0054			.0217		.0051
482	21.9544		7.8405		530	23.0217		8.0926	
		.0228		.0054			.0217		.0051
483	21.9772		7.8460		531	23.0434		8.0977	
		.0228		.0055			.0217		.0051
484	22.0000		7.8514		532	23.0651		8.1028	
		.0227		.0054			.0216		.0051
485	22.0227		7.8568		533	23.0867		8.1079	
		.0227		.0054			.0217		.0050
486	22.0454		7.8622		534	23.1084		8.1129	
		.0226		.0054			.0216		.0051
487	22.0680		7.8676		535	23.1300		8.1180	
		.0227		.0054			.0216		.0050
488	22.0907		7.8729		536	23.1516		8.1230	
		.0226		.0053			.0216		.0051
489	22.1133		7.8783		537	23.1732		8.1281	
		.0226		.0054			.0216		.0050
490	22.1359		7.8837		538	23.1948		8.1331	
		.0226		.0054			.0215		.0051
491	22.1585		7.8890		539	23.2163		8.1382	
		.0225		.0053			.0216		.0050
492	22.1810		7.8944		540	23.2379		8.1432	
		.0226		.0054			.0215		.0050
493	22.2036		7.8997		541	23.2594		8.1482	
		.0225		.0053			.0214		.0050
494	22.2261		7.9051		542	23.2808		8.1532	
		.0224		.0054			.0215		.0051
495	22.2485		7.9104		543	23.3023		8.1583	
		.0225		.0053			.0215		.0050
496	22.2710		7.9157		544	23.3238		8.1633	
		.0224		.0053			.0214		.0050
497	22.2934		7.9210		545	23.3452		8.1683	
		.0225		.0053			.0214		.0050
498	22.3159		7.9264		546	23.3666		8.1733	
		.0224		.0054			.0214		.0049
499	22.3383		7.9317		547	23.3880		8.1782	
		.0223		.0053			.0213		.0050
500	22.3606		7.9370		548	23.4093		8.1832	
		.0224		.0052			.0214		.0050
501	22.3830		7.9422		549	23.4307		8.1882	
		.0223		.0053			.0213		.0050
502	22.4053		7.9475		550	23.4520		8.1932	
		.0223		.0053			.0213		.0049
503	22.4276		7.9528		551	23.4733		8.1981	
		.0223		.0053			.0213		.0050
504	22.4499		7.9581		552	23.4946		8.2031	
		.0223		.0052			.0213		.0049
505	22.4722		7.9633		553	23.5159		8.2080	
		.0222		.0053			.0213		.0050
506	22.4944		7.9686		554	23.5372		8.2130	
		.0222		.0052			.0212		.0049
507	22.5166		7.9738		555	23.5584		8.2179	
		.0222		.0053			.0212		.0049
508	22.5388		7.9791		556	23.5796		8.2228	
		.0222		.0052			.0212		.0050
509	22.5610		7.9843		557	23.6008		8.2278	
		.0221		.0052			.0212		.0049
510	22.5831		7.9895		558	23.6220		8.2327	
		.0222		.0052			.0211		.0049
511	22.6053		7.9947		559	23.6431		8.2376	
		.0221		.0053			.0212		.0049
512	22.6274		8.0000		560	23.6643		8.2425	
		.0221		.0052			.0211		.0049
513	22.6495		8.0052		561	23.6854		8.2474	
		.0220		.0052			.0211		.0049
514	22.6715		8.0104		562	23.7065		8.2523	
		.0221		.0051			.0211		.0049
515	22.6936		8.0155		563	23.7276		8.2572	
		.0220		.0052			.0210		.0049
516	22.7156		8.0207		564	23.7486		8.2621	
		.0220		.0052			.0211		.0049
517	22.7376		8.0259		565	23.7697		8.2670	
		.0220		.0052			.0210		.0049
518	22.7596		8.0311		566	23.7907		8.2719	
		.0219		.0051			.0210		.0048
519	22.7815		8.0362		567	23.8117		8.2767	
		.0220		.0052			.0210		.0049
520	22.8035		8.0414		568	23.8327		8.2816	
		.0219		.0052			.0210		.0048
521	22.8254		8.0466		569	23.8537		8.2864	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
569	23.8537	.0209	8.2864	.0049	617	24.8394	.0202	8.5132	.0046
570	23.8746	.0210	8.2913	.0048	618	24.8596	.0201	8.5178	.0046
571	23.8956	.0209	8.2961	.0049	619	24 8797	.0200	8.5224	.0046
572	23.9165	.0209	8.3010	.0048	620	24.8997	.0201	8.5270	.0046
573	23.9374	.0208	8.3058	.0048	621	24.9198	.0201	8.5316	.0045
574	23.9582	.0209	8.3106	.0049	622	24.9399	.0200	8.5361	.0046
575	23.9791	.0209	8.3155	.0048	623	24.9599	.0200	8.5407	.0046
576	24.0000	.0208	8.3203	.0048	624	24.9799	.0200	8.5453	.0045
577	24.0208	.0208	8.3251	.0048	625	25.0000	.0199	8.5498	.0046
578	24.0416	.0208	8.3299	.0048	626	25.0199	.0200	8.5544	.0045
579	24.0624	.0207	8.3347	.0048	627	25.0399	.0200	8.5589	.0046
580	24.0831	.0208	8.3395	.0048	628	25.0599	.0199	8.5635	.0045
581	24.1039	.0207	8.3443	.0048	629	25.0798	.0200	8.5680	.0046
582	24.1246	.0207	8.3491	.0048	630	25.0998	.0199	8.5726	.0045
583	24.1453	.0207	8.3539	.0047	631	25.1197	.0198	8.5771	.0045
584	24.1660	.0207	8.3586	.0048	632	25.1396	.0198	8.5816	.0046
585	24.1867	.0207	8.3634	.0048	633	25.1594	.0199	8.5862	.0045
586	24.2074	.0206	8.3682	.0047	634	25.1793	.0199	8.5907	.0045
587	24.2280	.0207	8.3729	.0048	635	25.1992	.0198	8.5952	.0045
588	24.2487	.0206	8.3777	.0047	636	25.2190	.0198	8.5997	.0045
589	24.2693	.0206	8.3824	.0048	637	25.2388	.0198	8.6042	.0045
590	24.2899	.0205	8.3872	.0047	638	25.2586	.0198	8.6087	.0045
591	24.3104	.0206	8.3919	.0047	639	25.2784	.0198	8.6132	.0045
592	24.3310	.0205	8.3966	.0047	640	25.2982	.0197	8.6177	.0045
593	24.3515	.0206	8.4013	.0048	641	25.3179	.0198	8.6222	.0045
594	24.3721	.0205	8.4061	.0047	642	25.3377	.0197	8.6267	.0044
595	24.3926	.0205	8.4108	.0047	643	25.3574	.0197	8.6311	.0045
596	24.4131	.0204	8.4155	.0047	644	25.3771	.0197	8.6356	.0045
597	24.4335	.0205	8.4202	.0047	645	25.3968	.0197	8.6401	.0044
598	24.4540	.0204	8.4249	.0047	646	25.4165	.0196	8.6445	.0045
599	24.4744	.0204	8.4296	.0047	647	25.4361	.0197	8.6490	.0044
600	24.4948	.0205	8.4343	.0047	648	25.4558	.0196	8.6534	.0045
601	24.5153	.0203	8.4390	.0046	649	25.4754	.0196	8.6579	.0044
602	24.5356	.0204	8.4436	.0047	650	25.4950	.0197	8.6623	.0045
603	24.5560	.0204	8.4483	.0047	651	25.5147	.0195	8.6668	.0044
604	24.5764	.0203	8.4530	.0046	652	25.5342	.0196	8.6712	.0044
605	24.5967	.0203	8.4576	.0047	653	25.5538	.0196	8.6756	.0045
606	24.6170	.0203	8.4623	.0047	654	25.5734	.0195	8.6801	.0044
607	24.6373	.0203	8.4670	.0046	655	25.5929	.0195	8.6845	.0044
608	24.6576	.0203	8.4716	.0046	656	25.6124	.0196	8.6889	.0044
609	24.6779	.0202	8.4762	.0047	657	25.6320	.0195	8.6933	.0044
610	24.6981	.0203	8.4809	.0046	658	25.6515	.0194	8.6977	.0044
611	24.7184	.0202	8.4855	.0046	659	25.6709	.0195	8.7021	.0044
612	24.7386	.0202	8.4901	.0047	660	25.6904	.0195	8.7065	.0044
613	24.7588	.0202	8.4948	.0046	661	25.7099	.0194	8.7109	.0044
614	24.7790	.0201	8.4994	.0046	662	25.7293	.0194	8.7153	.0044
615	24.7991	.0202	8.5040	.0046	663	25.7487	.0194	8.7197	.0044
616	24.8193	.0201	8.5086	.0046	664	25.7681	.0194	8.7241	.0044
617	24.8394		8.5132		665	25.7875		8.7285	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
665	25.7875	.0194	8.7285	.0043	713	26.7020	.0187	8.9336	.0042
666	25.8069	.0194	8.7328	.0044	714	26.7207	.0187	8.9378	.0042
667	25.8263	.0193	8.7372	.0044	715	26.7394	.0187	8.9420	.0041
668	25.8456	.0194	8.7416	.0043	716	26.7581	.0187	8.9461	.0042
669	25.8650	.0193	8.7459	.0044	717	26.7768	.0187	8.9503	.0042
670	25.8843	.0193	8.7503	.0043	718	26.7955	.0187	8.9545	.0041
671	25.9036	.0193	8.7546	.0044	719	26.8141	.0187	8.9586	.0042
672	25.9229	.0193	8.7590	.0043	720	26.8328	.0186	8.9628	.0041
673	25.9422	.0193	8.7633	.0044	721	26.8514	.0186	8.9669	.0042
674	25.9615	.0192	8.7677	.0043	722	26.8700	.0186	8.9711	.0041
675	25.9807	.0193	8.7720	.0043	723	26.8886	.0186	8.9752	.0041
676	26.0000	.0192	8.7763	.0044	724	26.9072	.0186	8.9793	.0042
677	26.0192	.0192	8.7807	.0043	725	26.9258	.0185	8.9835	.0041
678	26.0384	.0192	8.7850	.0043	726	26.9443	.0186	8.9876	.0041
679	26.0576	.0192	8.7893	.0043	727	26.9629	.0185	8.9917	.0041
680	26.0768	.0191	8.7936	.0043	728	26.9814	.0186	8.9958	.0042
681	26.0959	.0192	8.7979	.0043	729	27.0000	.0185	9.0000	.0041
682	26.1151	.0191	8.8022	.0043	730	27.0185	.0185	9.0041	.0041
683	26.1342	.0191	8.8065	.0043	731	27.0370	.0184	9.0082	.0041
684	26.1533	.0191	8.8108	.0043	732	27.0554	.0185	9.0123	.0041
685	26.1725	.0192	8.8151	.0043	733	27.0739	.0185	9.0164	.0041
686	26.1916	.0190	8.8194	.0043	734	27.0924	.0184	9.0205	.0041
687	26.2106	.0191	8.8237	.0043	735	27.1108	.0185	9.0246	.0041
688	26.2297	.0191	8.8280	.0042	736	27.1293	.0184	9.0287	.0041
689	26.2488	.0190	8.8322	.0043	737	27.1477	.0184	9.0328	.0040
690	26.2678	.0190	8.8365	.0043	738	27.1661	.0184	9.0368	.0041
691	26.2868	.0190	8.8408	.0042	739	27.1845	.0184	9.0409	.0041
692	26.3058	.0190	8.8450	.0043	740	27.2029	.0184	9.0450	.0041
693	26.3248	.0190	8.8493	.0042	741	27.2213	.0184	9.0491	.0040
694	26.3438	.0190	8.8535	.0043	742	27.2396	.0183	9.0531	.0041
695	26.3628	.0190	8.8578	.0042	743	27.2580	.0184	9.0572	.0041
696	26.3818	.0189	8.8620	.0043	744	27.2763	.0183	9.0613	.0040
697	26.4007	.0189	8.8663	.0042	745	27.2946	.0183	9.0653	.0041
698	26.4196	.0189	8.8705	.0043	746	27.3130	.0184	9.0694	.0040
699	26.4386	.0189	8.8748	.0042	747	27.3313	.0183	9.0734	.0041
700	26.4575	.0189	8.8790	.0042	748	27.3495	.0182	9.0775	.0040
701	26.4764	.0188	8.8832	.0042	749	27.3678	.0183	9.0815	.0041
702	26.4952	.0189	8.8874	.0043	750	27.3861	.0183	9.0856	.0040
703	26.5141	.0188	8.8917	.0042	751	27.4043	.0182	9.0896	.0040
704	26.5329	.0189	8.8959	.0042	752	27.4226	.0183	9.0936	.0041
705	26.5518	.0188	8.9001	.0042	753	27.4408	.0182	9.0977	.0040
706	26.5706	.0188	8.9043	.0042	754	27.4590	.0182	9.1017	.0040
707	26.5894	.0188	8.9085	.0042	755	27.4772	.0182	9.1057	.0040
708	26.6082	.0188	8.9127	.0042	756	27.4954	.0182	9.1097	.0040
709	26.6270	.0188	8.9169	.0042	757	27.5136	.0182	9.1137	.0040
710	26.6458	.0187	8.9211	.0042	758	27.5317	.0181	9.1177	.0041
711	26.6645	.0188	8.9253	.0041	759	27.5499	.0182	9.1218	.0040
712	26.6833	.0187	8.9294	.0042	760	27.5680	.0181	9.1258	.0040
713	26.7020		8.9336		761	27.5862	.0182	9.1298	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
761	27.5862	.0181	9.1298	.0040	809	28.4429	.0175	9.3178	.0038
762	27.6043	.0181	9.1338	.0039	810	28.4604	.0176	9.3216	.0039
763	27.6224	.0181	9.1377	.0040	811	28.4780	.0176	9.3255	.0038
764	27.6405	.0181	9.1417	.0040	812	28.4956	.0175	9.3293	.0038
765	27.6586	.0181	9.1457	.0040	813	28.5131	.0175	9.3331	.0039
766	27.6767	.0180	9.1497	.0040	814	28.5306	.0176	9.3370	.0038
767	27.6947	.0181	9.1537	.0040	815	28.5482	.0175	9.3408	.0038
768	27.7128	.0180	9.1577	.0039	816	28.5657	.0175	9.3446	.0038
769	27.7308	.0180	9.1616	.0040	817	28.5832	.0174	9.3484	.0038
770	27.7488	.0180	9.1656	.0040	818	28.6006	.0175	9.3522	.0038
771	27.7668	.0180	9.1696	.0039	819	28.6181	.0175	9.3560	.0039
772	27.7848	.0180	9.1735	.0040	820	28.6356	.0174	9.3599	.0038
773	27.8028	.0180	9.1775	.0040	821	28.6530	.0175	9.3637	.0038
774	27.8208	.0180	9.1815	.0039	822	28.6705	.0174	9.3675	.0038
775	27.8388	.0179	9.1854	.0040	823	28.6879	.0175	9.3713	.0037
776	27.8567	.0180	9.1894	.0039	824	28.7054	.0174	9.3750	.0038
777	27.8747	.0179	9.1933	.0039	825	28.7228	.0174	9.3788	.0038
778	27.8926	.0179	9.1972	.0040	826	28.7402	.0174	9.3826	.0038
779	27.9105	.0179	9.2012	.0039	827	28.7576	.0173	9.3864	.0038
780	27.9284	.0179	9.2051	.0039	828	28.7749	.0174	9.3902	.0038
781	27.9463	.0179	9.2090	.0040	829	28.7923	.0174	9.3940	.0037
782	27.9642	.0179	9.2130	.0039	830	28.8097	.0173	9.3977	.0038
783	27.9821	.0179	9.2169	.0039	831	28.8270	.0174	9.4015	.0038
784	28.0000	.0178	9.2208	.0039	832	28.8444	.0173	9.4053	.0038
785	28.0178	.0178	9.2247	.0040	833	28.8617	.0173	9.4091	.0037
786	28.0356	.0179	9.2287	.0039	834	28.8790	.0173	9.4128	.0038
787	28.0535	.0178	9.2326	.0039	835	28.8963	.0173	9.4166	.0037
788	28.0713	.0178	9.2365	.0039	836	28.9136	.0173	9.4203	.0038
789	28.0891	.0178	9.2404	.0039	837	28.9309	.0173	9.4241	.0037
790	28.1069	.0176	9.2443	.0039	838	28.9482	.0172	9.4278	.0038
791	28.1247	.0177	9.2482	.0039	839	28.9654	.0173	9.4316	.0037
792	28.1424	.0178	9.2521	.0039	840	28.9827	.0173	9.4353	.0038
793	28.1602	.0178	9.2560	.0039	841	29.0000	.0172	9.4391	.0037
794	28.1780	.0177	9.2599	.0038	842	29.0172	.0172	9.4428	.0038
795	28.1957	.0177	9.2637	.0039	843	29.0344	.0172	9.4466	.0037
796	28.2134	.0177	9.2676	.0039	844	29.0516	.0172	9.4503	.0037
797	28.2311	.0177	9.2715	.0039	845	29.0688	.0172	9.4540	.0037
798	28.2488	.0177	9.2754	.0039	846	29.0860	.0172	9.4577	.0038
799	28.2665	.0177	9.2793	.0038	847	29.1032	.0172	9.4615	.0037
800	28.2842	.0177	9.2831	.0039	848	29.1204	.0172	9.4652	.0037
801	28.3019	.0177	9.2870	.0039	849	29.1376	.0171	9.4689	.0037
802	28.3196	.0176	9.2909	.0038	850	29.1547	.0172	9.4726	.0038
803	28.3372	.0176	9.2947	.0039	851	29.1719	.0171	9.4761	.0040
804	28.3548	.0177	9.2986	.0038	852	29.1890	.0171	9.4801	.0037
805	28.3725	.0176	9.3024	.0039	853	29.2061	.0171	9.4838	.0037
806	28.3901	.0176	9.3063	.0038	854	29.2232	.0171	9.4875	.0037
807	28.4077	.0176	9.3101	.0039	855	29.2403	.0171	9.4912	.0037
808	28.4253	.0176	9.3140	.0038	856	29.2574	.0171	9.4949	.0037
809	28.4429		9.3178		857	29.2745		9.4986	

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
857	29.2745	.0171	9.4986	.0037	905	30.0832	.0166	9.6727	.0036
858	29.2916	.0171	9.5023	.0036	906	30.0998	.0166	9.6763	.0035
859	29.3087	.0170	9.5059	.0037	907	30.1164	.0166	9.6798	.0036
860	29.3257	.0171	9.5096	.0037	908	30.1330	.0166	9.6834	.0035
861	29.3428	.0170	9.5133	.0037	909	30.1496	.0166	9.6869	.0036
862	29.3598	.0170	9.5170	.0037	910	30.1662	.0166	9.6905	.0035
863	29.3768	.0170	9.5207	.0037	911	30.1827	.0165	9.6940	.0036
864	29.3938	.0170	9.5244	.0036	912	30.1993	.0166	9.6976	.0035
865	29.4108	.0170	9.5280	.0037	913	30.2158	.0165	9.7011	.0035
866	29.4278	.0170	9.5317	.0037	914	30.2324	.0166	9.7046	.0036
867	29.4448	.0170	9.5354	.0036	915	30.2489	.0165	9.7082	.0035
868	29.4618	.0170	9.5390	.0037	916	30.2654	.0165	9.7117	.0036
869	29.4788	.0169	9.5427	.0037	917	30.2820	.0166	9.7153	.0035
870	29.4957	.0170	9.5464	.0036	918	30.2985	.0165	9.7188	.0035
871	29.5127	.0169	9.5500	.0037	919	30.3150	.0165	9.7223	.0035
872	29.5296	.0169	9.5537	.0036	920	30.3315	.0165	9.7258	.0036
873	29.5465	.0169	9.5573	.0037	921	30.3479	.0164	9.7294	.0035
874	29.5634	.0169	9.5610	.0036	922	30.3644	.0165	9.7329	.0035
875	29.5803	.0169	9.5646	.0036	923	30.3809	.0165	9.7364	.0035
876	29.5972	.0169	9.5682	.0037	924	30.3973	.0164	9.7399	.0035
877	29.6141	.0169	9.5719	.0036	925	30.4138	.0165	9.7434	.0035
878	29.6310	.0169	9.5755	.0037	926	30.4302	.0164	9.7469	.0035
879	29.6479	.0168	9.5792	.0036	927	30.4466	.0164	9.7504	.0035
880	29.6647	.0169	9.5828	.0036	928	30.4630	.0164	9.7539	.0036
881	29.6816	.0168	9.5864	.0036	929	30.4795	.0165	9.7575	.0035
882	29.6984	.0169	9.5900	.0037	930	30.4959	.0164	9.7610	.0044
883	29.7153	.0168	9.5937	.0036	931	30.5122	.0163	9.7644	.0035
884	29.7321	.0168	9.5973	.0036	932	30.5286	.0164	9.7679	.0035
885	29.7489	.0168	9.6009	.0036	933	30.5450	.0164	9.7714	.0035
886	29.7657	.0168	9.6045	.0036	934	30.5614	.0164	9.7749	.0035
887	29.7825	.0168	9.6081	.0036	935	30.5777	.0163	9.7784	.0035
888	29.7993	.0168	9.6117	.0036	936	30.5941	.0164	9.7829	.0035
889	29.8161	.0167	9.6153	.0037	937	30.6104	.0163	9.7854	.0035
890	29.8328	.0168	9.6190	.0036	938	30.6267	.0163	9.7889	.0034
891	29.8496	.0167	9.6226	.0036	939	30.6431	.0164	9.7923	.0035
892	29.8663	.0168	9.6262	.0035	940	30.6594	.0163	9.7958	.0035
893	29.8831	.0167	9.6297	.0036	941	30.6757	.0163	9.7993	.0035
894	29.8998	.0167	9.6333	.0036	942	30.6920	.0163	9.8028	.0034
895	29.9165	.0167	9.6369	.0036	943	30.7083	.0163	9.8062	.0035
896	29.9332	.0167	9.6405	.0036	944	30.7245	.0162	9.8097	.0034
897	29.9499	.0167	9.6441	.0036	945	30.7408	.0163	9.8131	.0035
898	29.9666	.0167	9.6477	.0036	946	30.7571	.0163	9.8166	.0035
899	29.9833	.0167	9.6513	.0035	947	30.7733	.0162	9.8201	.0034
900	30.0000	.0166	9.6548	.0036	948	30.7896	.0163	9.8235	.0035
901	30.0166	.0167	9.6584	.0036	949	30.8058	.0162	9.8270	.0034
902	30.0333	.0166	9.6620	.0036	950	30.8220	.0162	9.8304	.0035
903	30.0499	.0166	9.6656	.0035	951	30.8382	.0162	9.8339	.0034
904	30.0665	.0167	9.6691	.0036	952	30.8544	.0162	9.8373	.0035
905	30.0832		9.6727		953	30.8706		9.8408	

	C. Ris.	Diff.	No.	Sqr. Ris.	Diff.
	9.4946	.0037	905		
	9.5023	.0037	906		
	9.5059	.0037	907		
	9.5096	.0037	908		
	9.5133	.0037	909		
	9.5170	.0037	910		
	9.5207	.0037			
	9.5244	.0037			
	9.5280	.0036			
	9.5317	.0037			
	9.5354	.0037			
	9.5390	.0036			
	9.5427	.0037			
	9.5464	.0037			
	9.5500	.0036			
	9.5537	.0037			
	9.5573	.0036			
	9.5610				
	9.5646				
	9.5683				
	9.5719				
	9.5756				
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	9.5828				
	9.5865				
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	9.5937				
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	9.6226				
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	9.6477				
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	9.9227				
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	9.9598				
	9.9632				
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	9.9866				
	9.9900				
	9.9933				
	9.9967				
	10.0000				

No.	Sqr. Rts.	Diff.	C. Rts.	Diff.	No.	Sqr. Rts.	Diff.	C. Rts.	Diff.
953	30.8706	.0162	9.8408	.0034	977	31.2569	.0160	9.9227	.0034
954	30.8868	.0162	9.8442	.0034	978	31.2729	.0160	9.9261	.0034
955	30.9030	.0162	9.8476	.0035	979	31.2889	.0160	6.9295	.0033
956	30.9192	.0162	9.8511	.0034	980	31.3049	.0160	9.9328	.0034
957	30.9354	.0162	9.8545	.0034	981	31.3209	.0159	9.9362	.0034
958	30.9515	.0161	9.8579	.0035	982	31.3368	.0160	9.9396	.0034
959	30.9677	.0161	9.8614	.0034	983	31.3528	.0159	9.9430	.0033
960	30.9838	.0162	9.8648	.0034	984	31.3687	.0160	9.9463	.0034
961	31.0000	.0161	9.8682	.0034	985	31.3847	.0159	9.9497	.0034
962	31.0161	.0161	9.8716	.0035	986	31.4006	.0159	9.9531	.0033
963	31.0322	.0161	9.8751	.0034	987	31.4165	.0159	9.9564	.0034
964	31.0483	.0161	9.8785	.0034	988	31.4324	.0159	9.9598	.0033
965	31.0644	.0161	9.8819	.0034	989	31.4483	.0159	9.9631	.0034
966	31.0805	.0161	9.8853	.0034	990	31.4642	.0159	9.9665	.0034
967	31.0966	.0160	9.8887	.0034	991	31.4801	.0159	9.9699	.0033
968	31.1126	.0161	9.8921	.0034	992	31.4960	.0159	9.9732	.0034
969	31.1287	.0161	9.8955	.0034	993	31.5119	.0158	9.9766	.0033
970	31.1448	.0160	9.8989	.0034	994	31.5277	.0159	9.9799	.0034
971	31.1608	.0161	9.9023	.0034	995	31.5436	.0158	9.9833	.0033
972	31.1769	.0160	9.9057	.0034	996	31.5594	.0159	9.9866	.0033
973	31.1929	.0160	9.9091	.0034	997	31.5753	.0158	9.9899	.0034
974	31.2089	.0160	9.9125	.0034	998	31.5911	.0158	9.9933	.0033
975	31.2249	.0160	9.9159	.0034	999	31.6069	.0158	9.9966	.0034
976	31.2409	.0160	9.9193	.0034	1000	31.6227		10.0000	
977	31.2569		9.9227						

TABLE

CONTAINING

THE SURFACE AND SOLIDITY OF SPHERES,

The Edge or Dimensions of Equal Cubes,

THE LENGTHS OF EQUAL CYLINDERS,

AND THE

WEIGHT OF EQUAL QUANTITIES OF WATER IN AVOIRDUPOIS LBS.

Dia.	Surface.	Solidity.	Cube.	Cylinder.	Water in lbs.
1 *in.*	3.1416	.5236	.8060	.6666	.0190
1/16	3.5465	.6280	.8563	.7082	.0227
1/8	3.9760	.7455	.9067	.7500	.0270
3/16	4.4301	.8767	.9571	.7917	.0317
1/4	4.9087	1.0226	1.0075	.8333	.0370
5/16	5.4117	1.1838	1.0578	.8750	.0428
3/8	5.9395	1.3611	1.1082	.9166	.0500
7/16	6.4918	1.5553	1.1586	.9583	.0563
1/2	7.0686	1.7671	1.2090	1.0000	.0640
9/16	7.6699	2.0000	1.2593	1.0416	.0723
5/8	8.2957	2.2467	1.3097	1.0833	.0813
11/16	8.9461	2.5161	1.3601	1.1349	.0910
3/4	9.6211	2.8061	1.4105	1.1666	.1015
13/16	10.3206	3.1176	1.4608	1.2083	.1128
7/8	11.0446	3.4514	1.5112	1.2500	.1250
15/16	11.7932	3.8081	1.5616	1.2916	.1377
2 *in.*	12.5664	4.1888	1.6020	1.3333	.1516
1/16	13.3640	4.5938	1.6633	1.3750	.1662
1/8	14.1862	5.0243	1.7127	1.4166	.1818
3/16	15.0330	5.4807	1.7631	1.4582	.1982
1/4	15.9043	5.9640	1.8135	1.5000	.2160
5/16	16.8000	6.4749	1.8638	1.5516	.2342
3/8	17.7205	7.0143	1.9142	1.5832	.2540
7/16	18.6655	7.5828	1.9646	1.6250	.2743
1/2	19.6350	8.1812	2.0150	1.6666	.2960
9/16	20.6290	8.8103	2.0653	1.7082	.3187
5/8	21.6475	9.4708	2.1157	1.7500	.3426
11/16	22.6907	10.1634	2.1661	1.7915	.3676
3/4	23.7583	10.8892	2.2165	1.8332	.3939
13/16	24.8505	11.6485	2.2668	1.8750	.4213
7/8	25.9672	12.4426	2.3172	1.9165	.4501
15/16	27.1085	13.2718	2.3676	1.9582	.4800
3 *in.*	28.2744	14.1372	2.4180	2.0000	.5114
1/16	29.4647	15.0392	2.4683	2.0415	.5440
1/8	30.6796	15.9790	2.5187	2.0832	.5780
3/16	31.9191	16.9570	2.5691	2.1250	.6133
1/4	33.1831	17.9742	2.6195	2.1665	.6401
5/16	35.3715	19.0311	2.6698	2.2082	.6884
3/8	35.7847	20.1289	2.7202	2.2500	.7281
7/16	37.1224	21.2680	2.7706	2.2915	.7693
1/2	38.4846	22.4493	2.8210	2.3332	.8120
9/16	39.8713	23.6735	2.8713	2.3750	.8561
5/8	41.2825	24 9415	2.9217	2.4166	.9021
11/16	42.7183	26.2539	2.9712	2.4582	.9496
3/4	44.1787	27.6117	3.0225	2.5000	.9987
13/16	45.6636	29.0102	3.0728	2.5415	1.0493
7/8	47.1730	30.4659	3.1232	2.5832	1.1020
15/16	48.7070	31.9640	3.1730	2.6250	1.1561

Dia.	Surface.	Solidity.	Cube.	Cylinder.	Water in lbs.
4 in.	50.2656	33.5104	3.2240	2.6665	1.1974
1/16	51.8486	35.1058	3.2743	2.7082	1.2698
1/8	53.4562	36.7511	3.3247	2.7500	1.3293
3/16	55.0884	38.4471	3.3751	2.7915	1.3906
1/4	56.7451	40.1944	3.4255	2.8332	1.4538
5/16	58.4262	42.0461	3.4758	2.8750	1.5208
3/8	60.1321	43.8463	3.5262	2.9165	1.5860
7/16	61.8625	45.7524	3.5766	2.9582	1.6550
1/2	63.6174	47.7127	3.6270	3.0000	1.7258
9/16	65.3968	49.7290	3.6773	3.0415	1.7987
5/8	67.2007	51.8006	3.7277	3.0832	1.8736
11/16	69.0352	53.9290	3.7781	3.1250	1.9506
3/4	70.8823	56.1151	3.8285	3.1665	2.0297
13/16	72.7599	58.3595	3.8788	3.2080	2.1109
7/8	74.6620	60.6629	3.9292	3.2500	2.1942
15/16	76.5887	62.9261	3.9796	3.2913	2.2760
5 in.	78.5400	65.4500	4.0300	3.3332	2.3673
1/16	80.5157	67.9351	4.0803	3.3750	2.4572
1/8	82.5160	70.4824	4.1307	3.4155	2.5453
3/16	84.5409	73.0926	4.1811	3.4582	2.6438
1/4	86.5903	75.7664	4.2315	3.5000	2.7605
5/16	88.6641	78.5077	4.2818	3.5414	2.8396
3/8	90.7627	81.3083	4.3322	3.5832	2.9407
7/16	92.8858	84.1777	4.3820	3.6250	3.0447
1/2	95.0334	87.1139	4.4330	3.6665	3.1509
9/16	97.2053	90.1175	4.4633	3.7080	3.2595
5/8	99.4021	93.1875	4.5337	3.7500	3.3706
11/16	101.6233	96.3304	4.5841	3.7913	3.4843
3/4	103.8691	99.5412	4.6345	3.8330	3.6004
13/16	106.1394	102.8225	4.6848	3.8750	3.7191
7/8	108.4342	106.1754	4.7352	3.9163	3.8404
15/16	110.7536	109.5973	4.7856	3.9580	3.9641
6 in.	113.0976	113.0976	4.8360	4.0000	4.0907
1/16	115.4660	116.6688	4.8863	4.0417	4.2200
1/8	117.8590	120.3139	4.9367	4.0833	4.3517
3/16	120.2771	124.0374	4.9871	4.1250	4.4874
1/4	122.7187	127.8320	5.0375	4.1666	4.6236
5/16	125.1852	131.7053	5.0878	4.2083	4.7638
3/8	127.6765	135.6563	5.1382	4.2500	4.9067
7/16	130.1923	139.6854	5.1886	4.2917	5.0524
1/2	132.7326	143.7936	5.2390	4.3332	5.2010
9/16	135.2974	147.9815	5.2893	4.3750	5.3525
5/8	137.8867	152.2499	5.3377	4.4165	5.5069
11/16	140.5006	156.5997	5.3901	4.4583	5.6786
3/4	143.1391	161.0315	5.4405	4.5000	5.8245
13/16	145.8021	167.5461	5.4908	4.5416	6.0601
7/8	148.4896	170.1682	5.5412	4.5832	6.1550
15/16	151.2017	174.8270	5.5916	4.6250	6.3235

Dia.	Surface.	Solidity.	Cube.	Cylinder.	Water in lbs.
7 in.	153.9384	179.5948	5.6420	4.6665	6.4960
1/16	156.6995	184.4484	5.6923	4.7082	6.6725
1/8	159.4852	189.3882	5.7427	4.7500	6.8502
3/16	162.2955	194.1165	5.7931	4.7915	7.0212
1/4	165.1303	199.5325	5.8435	4.8332	7.2171
5/16	167.9895	204.7371	5.8938	4.8750	7.4053
3/8	170.8735	210.0331	5.9442	4.9166	7.5970
7/16	173.7520	215.4172	5.9946	4.9582	7.7916
1/2	176.7150	220.8937	6.0450	5.0000	7.9897
9/16	179.6725	226.7240	6.0953	5.0415	8.2006
5/8	182.6545	232.1235	6.1457	5.0832	8.3960
11/16	185.6611	237.8883	6.1961	5.1250	8.6044
3/4	188.6923	243.7276	6.2465	5.1665	8.8157
13/16	191.7480	249.4720	6.2968	5.2082	9.0234
7/8	194.8282	255.7121	6.3472	5.2500	9.2491
15/16	197.9330	261.9673	6.3976	5.2913	9.4753
8 in.	201.0624	268.0832	6.4480	5.3330	9.6965
1/16	204.2162	274.4156	6.4983	5.3750	9.9260
1/8	207.3946	280.8469	6.5487	5.4164	10.1583
3/16	210.5976	287.3780	6.5991	5.4581	10.3944
1/4	213.8251	294.0095	6.6495	5.5000	10.6343
5/16	217.0770	300.7422	6.6998	5.5414	10.8778
3/8	220.3537	307.5771	6.7502	5.5831	11.1250
7/16	223.6549	314.5147	6.8006	5.6250	11.3769
1/2	226.9806	321.5555	6.8510	5.6664	11.6306
9/16	230.3308	328.7012	6.9013	5.7080	11.8891
5/8	233.7055	335.9517	6.9517	5.7500	12.1514
11/16	237.1048	343.3079	7.0021	5.7913	12.4170
3/4	240.5287	350.7710	7.0525	5.8330	12.6874
13/16	243.9771	358.3412	7.1028	5.8750	12.9612
7/8	247.4500	366.0199	7.1532	5.9163	13.2390
15/16	250.9475	373.8073	7.2036	5.9580	13.5206
9 in.	254.4696	381.7017	7.2540	6.0000	13.8062
1/16	258.0261	389.7118	7.3043	6.0417	14.0959
1/8	261.5872	397.8306	7.3547	6.0833	14.3895
3/16	265.1829	406.0613	7.4051	6.1250	14.6872
1/4	268.8031	414.4048	7.4555	6.1667	14.9890
5/13	272.4477	421.2907	7.5058	6.2083	15.2381
3/8	276.1171	431.4361	7.5562	6.2500	15.6050
7/16	279.8110	440.1294	7.6066	6.2916	15.9195
1/2	283.5294	448.9215	7.6570	6.3333	16.2375
9/16	287.2723	457.8500	7.7073	6.3750	16.5604
5/8	291.0397	466.8763	7.7557	6.4166	16.6869
11/16	294.8310	476.0304	7.8081	6.4582	17.2180
3/4	298.4483	485.3035	7.8585	6.5000	17.5534
13/16	302.4894	494.6952	7.9088	6.5415	17.8931
7/8	306.3550	504.2094	7.9592	6.5832	18.2373
15/16	310.9452	513.8436	8.0096	6.6250	18.5857

Dia.	Surface.	Solidity.	Cube.	Cylinder.	Water in lbs.
10 *in.*	314.1600	523.6000	8.0600	6.6666	18.6786
1/16	318.0992	533.4789	8.1103	6.7083	19.2960
1/8	322.0630	543.4814	8.1607	6.7500	19.6577
3/16	326.0514	553.6081	8.2111	6.7916	20.0240
1/4	330.0643	563.8603	8.2615	6.8333	20.3948
5/16	334.1016	574.2371	8.3118	6.8750	20.6682
3/8	338.1637	584.7415	8.3622	6.9166	21.1501
7/16	342.2503	595.3677	8.4126	6.9582	21.5344
1/2	346.3614	606.1318	8.4630	7.0000	21.9238
9/16	350.4970	617.0207	8.5133	7.0416	22.3176
5/8	354.6571	628.0387	8.5637	7.0833	22.7162
11/16	358.8418	639.1871	8.6141	7.1250	23.1194
3/4	363.0511	650.4666	8.6645	7.1666	23.5274
13/16	367.2849	661.8580	8.7148	7.2082	23.9394
7/8	371.5432	673.4222	8.7652	7.2500	24.3577
15/16	375.8261	685.0997	8.8156	7.2915	24.7801
11 *in.*	380.1336	696.9116	8.8660	7.3330	25.2073
1/16	384.4655	708.9106	8.9163	7.3750	25.6414
1/8	388.8220	720.9409	8.9667	7.4165	26.0764
3/16	393.2031	733.1599	9.0171	7.4582	26.5184
1/4	397.6087	745.5004	9.0675	7.5000	26.5657
5/16	402.0387	758.0104	9.1178	7.5414	27.4162
3/8	406.4935	770.6440	9.1682	7.5832	27.8742
7/16	410.7728	783.5787	9.2186	7.6250	28.3420
1/2	415.4766	796.3301	9.2690	7.6664	28.8033
9/16	420.0049	809.3844	9.3193	7.7080	29.2754
5/8	424.5576	822.5807	9.3697	7.7500	29.7527
11/16	429.1351	835.9695	9.4201	7.7913	30.2370
3/4	433.7371	849.4035	9.4705	7.8330	30.7229
13/16	438.3636	863.0283	9.5208	7.8750	31.2157
7/8	443.0146	876.7999	9.5772	7.9163	31.3883
15/16	447.6902	890.7070	9.6216	7.9580	32.2169
12 *in.*	452.3904	904.7808	9.6720	8.0000	32.7259
1/4	471.4363	962.5158	9.8735	8.1666	34.8142
1/2	490.8750	1022.656	10.0750	8.3332	36.9886
3/4	506.7064	1085.251	10.2765	8.5000	39.2535
13 *in.*	530.9304	1150.337	10.4780	8.6666	41.6077
1/4	551.5471	1218.000	10.6790	8.8332	44.0551
1/2	572.5566	1288.252	10.8810	9.0000	46.5961
3/4	593.9587	1361.346	11.0825	9.1665	49.2399
14 *in.*	615.7536	1436.758	11.2840	9.3332	51.9675
1/4	637.9411	1515.106	11.4855	9.5000	54.8014
1/2	660.5214	1596.260	11.6870	9.6665	57.7367
3/4	683.4943	1680.265	11.8885	9.8332	60.7751
15 *in.*	706.8600	1767.150	12.0900	10.0000	64.0178
1/4	730.6183	1856.988	12.2915	10.1666	67.1672
1/2	754.7694	1949.821	12.4930	10.3332	70.5250
3/4	779.3131	2045.697	12.6940	10.5000	73.9929
16 *in.*	804.2496	2144.665	12.8960	10.6666	77.5725

TABLE OF RECIPROCALS

FOR OBTAINING DECIMAL EQUIVALENTS.

No.	Recip.	No.	Recip.	No.	Recip.	No.	Recip.	No.	Recip.
1	1.000000	51	.019607	101	.009900	151	.006623	201	.004975
2	.500000	52	.019231	102	.009803	152	.006579	202	.004951
3	.333333	53	.018868	103	.009709	153	.006536	203	.004927
4	.250000	54	.018519	104	.009616	154	.006494	204	.004901
5	.200000	55	.018182	105	.009523	155	.006451	205	.004879
6	.166667	56	.017857	106	.009433	156	.006411	206	.004855
7	.142857	57	.017543	107	.009345	157	.006370	207	.004831
8	.125000	58	.017242	108	.009260	158	.006329	208	.004807
9	.111111	59	.016949	109	.009174	159	.006290	209	.004785
10	.100000	60	.016667	110	.009091	160	.006250	210	.004762
11	.090901	61	.016393	111	.009010	161	.006211	211	.004740
12	.083333	62	.016129	112	.008928	162	.006172	212	.004716
13	.076923	63	.015873	113	.008850	163	.006135	213	.004695
14	.071428	64	.015625	114	.008771	164	.006097	214	.004673
15	.066667	65	.015385	115	.008695	165	.006061	215	.004651
16	.062500	66	.015151	116	.008620	166	.006025	216	.004629
17	.058823	67	.014925	117	.008548	167	.005988	217	.004649
18	.055556	68	.014706	118	.008475	168	.005952	218	.004588
19	.052632	69	.014492	119	.008403	169	.005917	219	.004566
20	.050000	70	.014285	120	.008333	170	.005882	220	.004546
21	.047620	71	.014085	121	.008264	171	.005847	221	.004525
22	.045455	72	.013889	122	.008196	172	.005813	222	.004505
23	.043078	73	.013698	123	.008130	173	.005781	223	.004485
24	.041667	74	.013513	124	.008065	174	.005748	224	.004465
25	.040000	75	.013333	125	.008000	175	.005715	225	.004444
26	.038462	76	.013158	126	.007936	176	.005682	226	.004425
27	.037038	77	.012987	127	.007875	177	.005650	227	.004406
28	.035715	78	.012820	128	.007812	178	.005618	228	.004386
29	.034483	79	.012659	129	.007752	179	.005586	229	.004366
30	.033333	80	.012500	130	.007693	180	.005556	230	.004348
31	.032259	81	.012346	131	.007634	181	.005524	231	.004329
32	.031250	82	.012195	132	.007576	182	.005495	232	.004311
33	.030303	83	.012048	133	.007519	183	.005464	233	.004292
34	.029412	84	.011904	134	.007463	184	.005434	234	.004273
35	.028572	85	.011765	135	.007408	185	.005406	235	.004256
36	.027778	86	.011628	136	.007352	186	.005376	236	.004238
37	.027028	87	.011494	137	.007299	187	.005347	237	.004220
38	.026316	88	.011364	138	.007247	188	.005320	238	.004201
39	.025642	89	.011235	139	.007195	189	.005292	239	.004184
40	.025000	90	.011111	140	.007143	190	.005264	240	.004167
41	.024390	91	.010989	141	.007093	191	.005235	241	.004150
42	.023809	92	.010870	142	.007042	192	.005208	242	.004132
43	.023255	93	.010753	143	.006994	193	.005182	243	.004116
44	.022727	94	.010639	144	.006944	194	.005155	244	.004098
45	.022222	95	.010527	145	.006896	195	.005129	245	.004081
46	.021739	96	.010417	146	.006850	196	.005102	246	.004065
47	.021276	97	.010310	147	.006802	197	.005076	247	.004048
48	.020833	98	.010204	148	.006756	198	.005051	248	.004033
49	.020408	99	.010101	149	.006712	199	.005026	249	.004016
50	.020000	100	.010000	150	.006667	200	.005000	250	.004000

The numbers in the table are the denominators of the fraction, hence, multiply the reciprocal of the denominator by the numerator of the fraction, and the product is the decimal equivalent.

Thus, suppose the decimal equivalent of 7-16 be required,

Reciprocal of 16 = .0625 × 7 = .4375 its decimal equivalent.

TABLE

CONTAINING

THE WEIGHT OF COLUMNS OF WATER,

EACH ONE FOOT IN LENGTH,

AND OF VARIOUS DIAMETERS,

IN LBS. AVOIRDUPOIS.

Dia.	Weight.	Dia.	Weight.	Dia.	Weight.
3 in.	3.0672	9 in.	27.6120	15 in.	76.7004
⅛	3.3288	⅛	28.3848	⅛	77.9844
¼	3.6000	¼	29.1672	¼	79.2792
⅜	3.8820	⅜	29.9604	⅜	80.5836
½	4.1748	½	30.7656	½	81.9000
⅝	4.4784	⅝	31.6524	⅝	83.2260
¾	4.7928	¾	32.4060	¾	84.5628
⅞	5.1180	⅞	33.2424	⅞	85.9104
4 in.	5.4540	10 in.	34.0884	16 in.	87.2688
⅛	5.7996	⅛	34.9464	⅛	88.6368
¼	6.1572	¼	35.8152	¼	90.0168
⅜	6.5244	⅜	36.6936	⅜	91.4176
½	6.9024	½	37.5828	½	92.8080
⅝	7.2912	⅝	38.4828	⅝	94.2192
¾	7.6908	¾	39.3936	¾	95.6412
⅞	8.1012	⅞	40.3152	⅞	97.0740
5 in.	8.5212	11 in.	41.2476	17 in.	98.5176
⅛	8.9532	⅛	42.1908	⅛	99.9720
¼	9.3948	¼	43.1436	¼	101.4372
⅜	9.8484	⅜	44.1084	⅜	102.9120
½	10.3128	½	45.0828	½	104.3988
⅝	10.7856	⅝	46.0680	⅝	105.8952
¾	11.2704	¾	47.0640	¾	107.4024
⅞	11.7660	⅞	48.0708	⅞	108.9204
6 in.	12.2712	12 in.	49.0884	18 in.	110.4492
⅛	12.7884	⅛	50.1168	⅛	111.9888
¼	13.3152	¼	51.1548	¼	113.5392
⅜	13.8540	⅜	52.2048	⅜	115.0992
½	14.4024	½	53.2644	½	116.6712
⅝	14.9616	⅝	54.3348	⅝	118.2528
¾	15.5316	¾	55.4760	¾	119.8452
⅞	16.1124	⅞	56.4804	⅞	121.4484
7 in.	16.7028	13 in.	57.6108	19 in.	123.0624
⅛	17.3052	⅛	58.7244	⅛	124.6872
¼	17.9172	¼	59.8476	¼	126.3228
⅜	18.5412	⅜	60.9828	⅜	127.9680
½	19.1748	½	62.1276	½	129.6252
⅝	19.8192	⅝	63.2832	⅝	131.5320
¾	20.4744	¾	64.4496	¾	132.9696
⅞	21.1404	⅞	65.6268	⅞	134.6580
8 in.	21.8172	14 in.	66.8148	20 in.	136.3562
⅛	22.5036	⅛	68.0136	⅛	138.0672
¼	23.2020	¼	69.2220	¼	139.7880
⅜	23.9100	⅜	70.4424	⅜	141.5194
½	24.5288	½	71.6724	½	143.2608
⅝	25.3524	⅝	72.9120	⅝	145.0128
¾	26.0988	¾	74.1648	¾	146.7756
⅞	26.8500	⅞	75.4272	⅞	148.5492

Dia.	Weight.	Dia.	Weight.	Dia.	Weight.
21 *in.*	150.2376	27 *in.*	248.5116	33 *in.*	371.2344
⅛	152.1288	⅛	250.8180	⅛	374.0520
¼	153.9348	¼	253.1352	¼	376.8004
⅜	155.7396	⅜	255.4632	⅜	379.4592
½	157.5780	½	257.8008	½	382.5684
⅝	159.4152	⅝	260.1504	⅝	385.4292
¾	161.2644	¾	262.5096	¾	388.2996
⅞	163.1220	⅞	264.8796	⅞	391.1820
22 *in.*	164.9928	28 *in.*	267.2616	34 *in.*	394.0740
⅛	166.8732	⅛	269.6532	⅛	396.9768
¼	168.7632	¼	272.0544	¼	399.8928
⅜	170.6652	⅜	275.6672	⅜	402.8088
½	172.5780	½	276.8916	½	405.7500
⅝	174.5004	⅝	279.3252	⅝	408.6948
¾	176.4336	¾	281.7708	¾	411.4116
⅞	178.3776	⅞	284.2260	⅞	414.6180
23 *in.*	180.3324	29 *in.*	286.6920	35 *in.*	417.5952
⅛	182 2980	⅛	289.1688	⅛	420.5844
¼	184.2744	¼	291.6564	¼	423.5832
⅜	186.2616	⅜	294.1548	⅜	426.5928
½	188.2584	½	296.5548	½	429.6120
⅝	190.2672	⅝	299.1828	⅝	432.6432
¾	192.2856	¾	301.7124	¾	435.6840
⅞	194 3184	⅞	304.2540	⅞	438.7368
24 *in.*	196.3548	30 *in.*	306.8052	36 *in.*	441.7992
⅛	198.4056	⅛	309.3672	⅛	447.9573
¼	200.4672	¼	311.9400	½	454.1678
⅜	203 5384	⅜	314.5224	¾	460.4105
½	204.6216	½	317.1168	37 *in.*	466.6960
⅝	206.7144	⅝	319.7220	¼	473.0240
¾	208 8192	¾	322.3368	½	479.3946
⅞	210.9336	⅞	324.9624	¾	485.8078
25 *in.*	213.0588	31 *in.*	327.6000	38 *in.*	492.2637
⅛	215.1948	⅛	330.2472	¼	498.7621
¼	217.3416	¼	332.9052	½	505.3032
⅜	219.4980	⅜	335.5728	¾	511.9979
½	221.6664	½	338.2524	39 *in.*	518.4132
⅝	223.8444	⅝	340.9428	¼	525.1821
¾	226.0344	¾	343.6428	½	531.8936
⅞	228.2340	⅞	346.3536	¾	538.6478
26 *in.*	230.4444	32 *in.*	349 0764	40 *in.*	545.4445
⅛	232.6644	⅛	351.8088	¼	552.2839
¼	234.8576	¼	354.5520	½	559.1659
⅜	237.1404	⅜	357.3048	¾	566.0904
½	239.3928	½	360.0696	41 *in.*	573.0577
⅝	241.6572	⅝	362.8452	½	587.1199
¾	243.9312	¾	365.6304	42 *in.*	601.3526
⅞	246.2160	⅞	868.4276	50 *in*	799.2426

The preceding tables are rendered of great utility by means of the following:—

The weight of Water	being	1.
——— Copper	=	8.8
——— Brass	=	8.4
——— Iron, cast	=	7.2
——— Lead	=	11.3
——— Zinc	=	7.2
——— Gun metal	=	8.7
——— Sand	=	1.5
——— Coal	=	1.25
——— Brick	=	2.0
——— Stone	=	2.5
——— Timber, average	=	0.85

EXAMPLE.—Suppose it be required to ascertain the weight of a cast iron pipe $26\frac{1}{4}$ inches outside and $23\frac{3}{4}$ inside, the length being $6\frac{1}{2}$ feet.

Opposite $26\frac{1}{4}$ in the table is

$234{,}8576 \times 7.2 \times 6.5 = 10991.135$

And opposite $23\frac{3}{4}$ in the table is

$192.2856 \times 7.2 \times 6.5 = 8998.966$ subtract

1992.169 lbs. Avs.

And in a similar manner the weight of a column or pipe of another material can easily be obtained.

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